JUN 2 4 1909

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AMERICAN MACHINIST

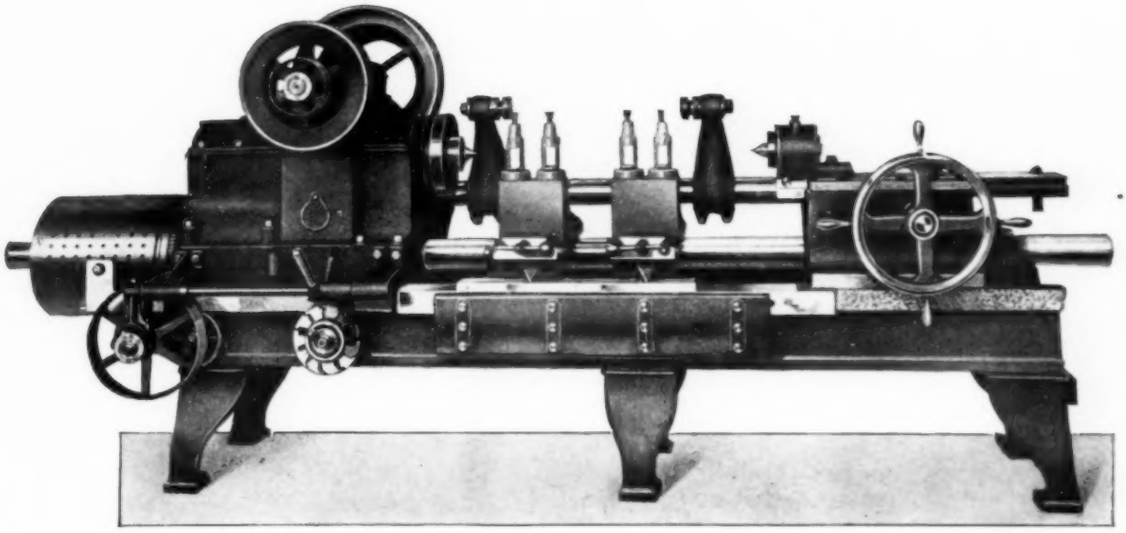
A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY,

Vol. 32. 505 PEARL STREET, NEW YORK. No. 25.

Index to Advertisers and Classified Index Following Reading Matter.

Fay 24 In. x 10 Ft. Automatic Turning Lathe



For turning cones, gears, pulleys; threading and facing pipe flanges and a lot of other work this lathe will save you money. One man runs from 4 to 6 lathes. Write for information.

Fay Machine Tool Company

Philadelphia, U. S. A.

48-in. Extra Heavy Rod Milling Machine.

Continuous, Heavy and Severe Service

will **not** injure the accuracy or the delicate alignments, or work loose the various parts **on the Bement Horizontal Rod Milling Machine.**

This machine is built for the severest continuous service. It is exceptionally heavy and well balanced. Each part in thorough keeping with the massive construction, and rigidly attached. Practically nothing to get out of order. Direct motor drive.

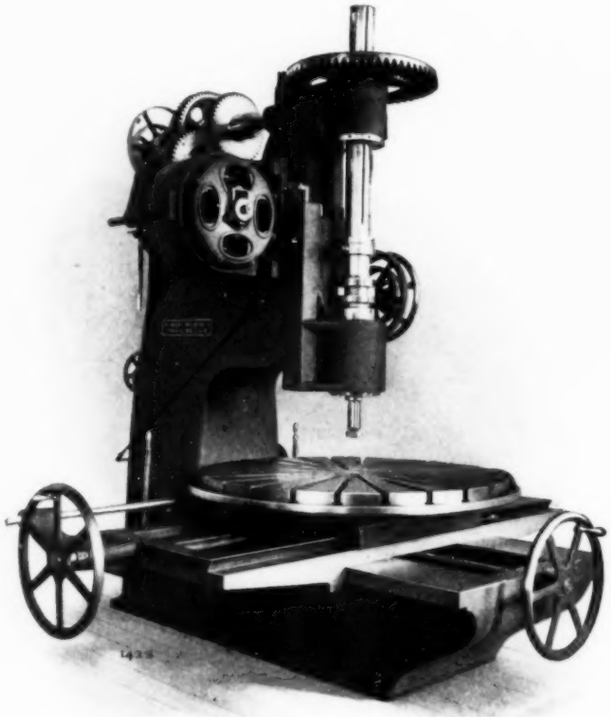
Catalog "Heavy Milling Machines" shows the various sizes and styles, sent upon request.

A Special Machine for Cutting Cams Is Not Necessary

The Bement Vertical Milling Machine

with the profiling or copying attachment will mill cams and other irregular shapes equally as efficiently and economically as a cam cutter. The machine is very powerful and limited only by the ability of the cutter to stand up. Convertible type, may be changed from belt to motor drive at any time.

Send for Catalog "Vertical Millers" describing the various sizes in detail.



66-in. Bement Vertical Milling Machine, 60-in. table.

NILES-BEMENT-POND COMPANY

111 Broadway, New York. **23-25 Victoria St., London, S. W.**

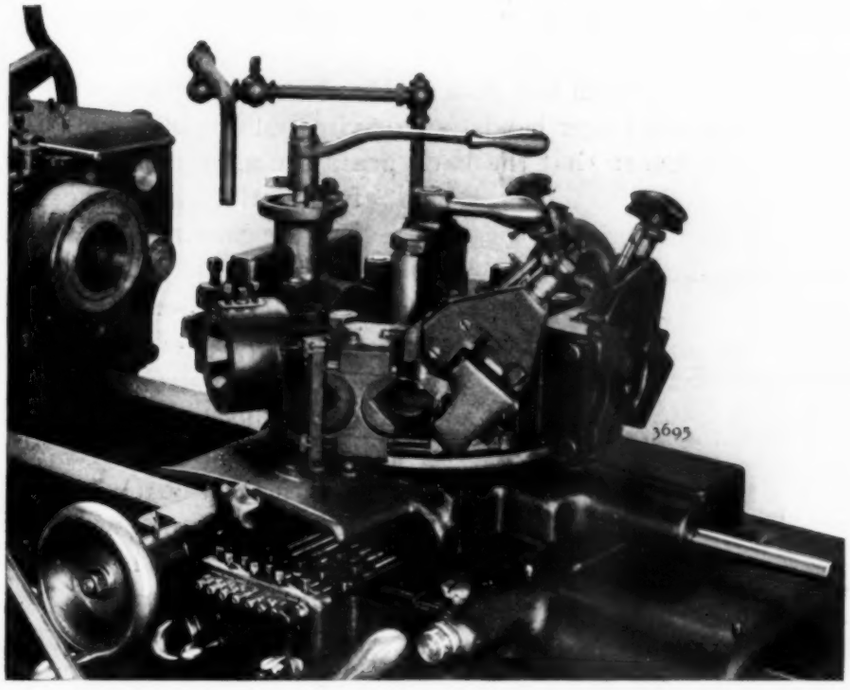
OFFICES:

Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala.: Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, St. John, Toronto, Winnipeg, Calgary and Vancouver. Agents for California, Nevada and Arizona: Harron, Rickard & McCone, 461 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. Ing. Ercole Vaghi, Milan, Italy. F. G. Kretschmer & Co., Frankfurt a.M., Germany. F. W. Horne, 70 C Yokohama, Japan.

(*See pages* 35, 36, 37, 38, 39, 40, 41 *and* 42)

Alone In Its Field

The P. & W. Open Turret Lathe with its Cross-Sliding Turret



P. & W. Open Turret Lathe showing Cross Sliding Turret with Rod Turning Tools.

A simple and positive cross-sliding turret has long been a desired feature on a turret lathe.

Various methods, have been devised, but none of them have had the desired adaptability or flexibility, or were free from belt and other annoyances, until the introduction of the **P. & W. Cross Sliding Turret.**

This addition completes the universality of the P. & W. Open Turret Lathe—a shop economizer on all bar and chuck work.

Send for Catalog "The Open Turret Lathe" illustrating numerous economic operations.

PRATT & WHITNEY COMPANY
HARTFORD, CONN., U. S. A.

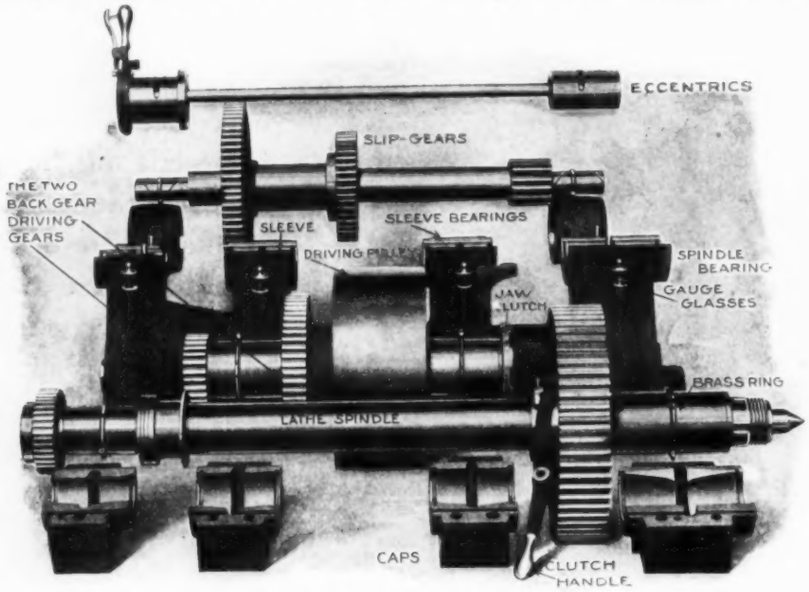
OFFICES—Trinity Building, 111 Broadway, New York. Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg., Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. **Agents:** California, Nevada and Arizona, Harron, Rickard & McCone, 461 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. The Canadian Fairbanks Co., Ltd., Montreal, St. John, Toronto, Winnipeg, Calgary and Vancouver.
AGENTS—BUCK & HICKMAN, Ltd., 2 and 4 Whitechapel Road, London, E. C. Niles-Bement-Pond Co., 23-25 Victoria St., London, S. W. Paris: Fenwick, Freres & Co., 8 Rue de Rocroy, Agents for France, Belgium and Switzerland. Italy: Ercole Vaghi, Milan, Germany: F. G. Kretschmer & Co., Frankfurt a.M. Japan: F. W. Horne, 70 C/- Yokohama.

(*See pages* 43, 44, 45, 46, 47 *and* 48)

Are Your Back Gears Noisy?

IF you use a Cone Head Lathe you find that the narrow belt compels you to run with the back gears in for all cuts except the lightest. You increase the belt speed in an attempt to get the needed power. This results in high speed of the gearing with greatly increased wear on the gear teeth as well as on the journals of the back gear shaft.

Now consider the back gear construction of the Patent Head Lathe as shown in the illustration. The much wider belt and larger headstock driving pulley give plenty of power on all six of the open belt speeds, so that the back gears are used much less frequently. Nevertheless the construction of the back gear shaft and journals has been greatly improved.



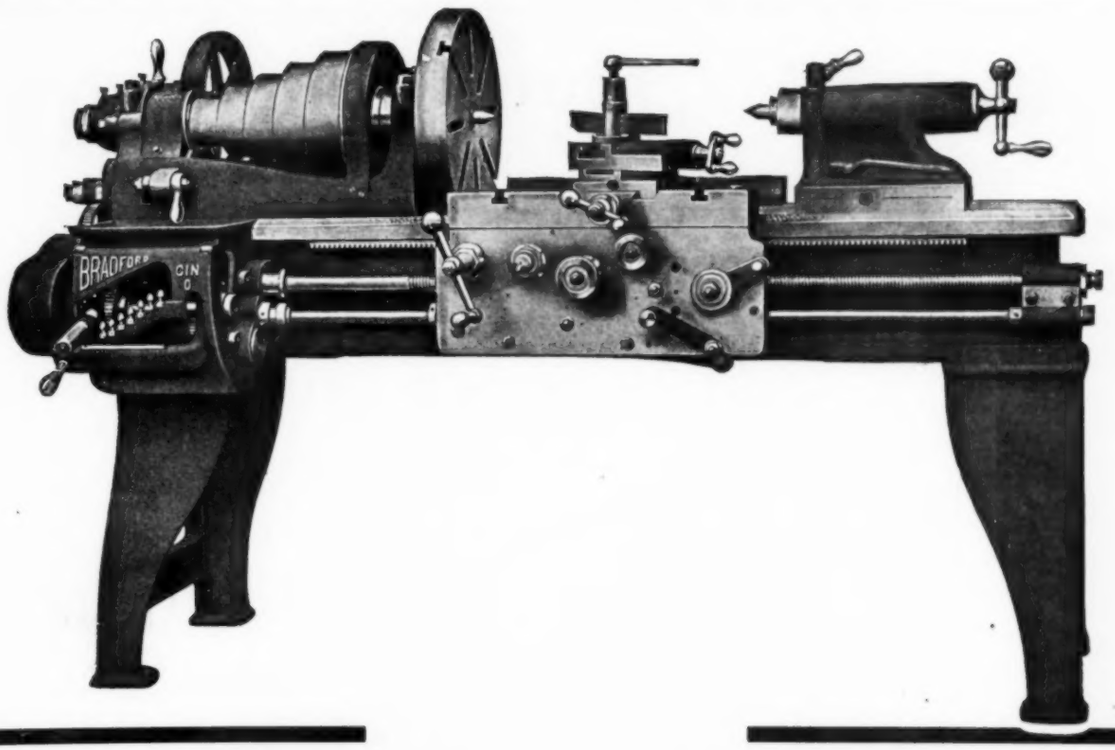
Assembly, Patent Headstock.

The journals are not reduced in size by turning the shaft eccentrically at each end. Instead, the throw of the back gear shaft is obtained by journalling the shaft in eccentrically bored bushes. The rod which ties together these bushes, passes through the shaft, but does not touch it, and only serves the purpose of rotating both bushes simultaneously. Adjustment for wear of the gear teeth is easily made by changing the degree of rotation of these eccentric bushes. The positive locking pin holds the back gears securely either in or out of gear, as may be desired, and insures that when in, the gears mesh correctly. The lubrication of the back gear shaft is secured by a highly efficient and positive system of ring-oilers, similar to that used on the lathe spindle.

The Lodge & Shipley Machine Tool Company

Cincinnati, Ohio

Domestic Agents: Brown & Zortmann Machinery Co., Pittsburg; Charlotte Supply Co., Charlotte; W. R. Colcord Machinery Co., St. Louis; M. E. Dewstoe, Birmingham; Hallidie Mchy. Co., Seattle, Spokane; Harron, Rickard & McCone, San Francisco, Los Angeles; Marshall & Huschart Machinery Co., Chicago; Morrison Machinery and Supply Co., Richmond; Motch & Merryweather Machinery Co., Cleveland, Detroit, Cincinnati; C. T. Patterson Co., Ltd., New Orleans; Prentiss Tool and Supply Co., New York, Boston, Buffalo, Syracuse; Robinson, Cary & Sands Co., St. Paul; W. E. Shipley Machinery Co., Philadelphia; Utah Mining Machinery and Supply Co., Salt Lake City; Vonnegut Hardware Co., Indianapolis; Zimmerman-Wells-Brown Co., Portland.



The Lathe For General Tool Room Practice

The 16-Inch Bradford places such work on the most economical basis, by embodying in its construction a multitude of cost-reducing features. Glance over these—remember that Bradford Lathes rank foremost among the tools manufactured in America —and then apply this 16-Inch Lathe to *your* requirements.

Range of threads and feeds practically unlimited, for either right or left-hand threads. Most direct drive from spindle to lead screw or feed rod. Screw not in motion except for screw cutting. One lever for all threads. Automatic stop for feeds. Cluster can be cut out entirely, driving the screw direct with ordinary change gears. Screw cutting and feeds without the removal of a gear. And other features—for which consult our Catalog.

NOTICE:—We can now equip our lathes from 14″ to 25″ inclusive; with either three or four step cone pulley as well as our regular five step cone.

The Bradford Machine Tool Company

Cincinnati, Ohio, U. S. A.

Vandyck, Churchill Co., New York and Philadelphia, Pa. Somers, Fitler & Todd Co., Pittsburg, Pa. J. W. Wright & Co., St. Louis, Mo. The H. A. Stocker Machinery Co., Chicago, Ill. Pacific Tool and Supply Co., San Francisco, Cal.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow, Newcastle-on-Tyne. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm, Copenhagen and Budapest. Alfred H. Schutte, Cologne. Brussels, Liege, Paris, Milan and Bilbao. F. W. Horne, Japan, China and Far East.

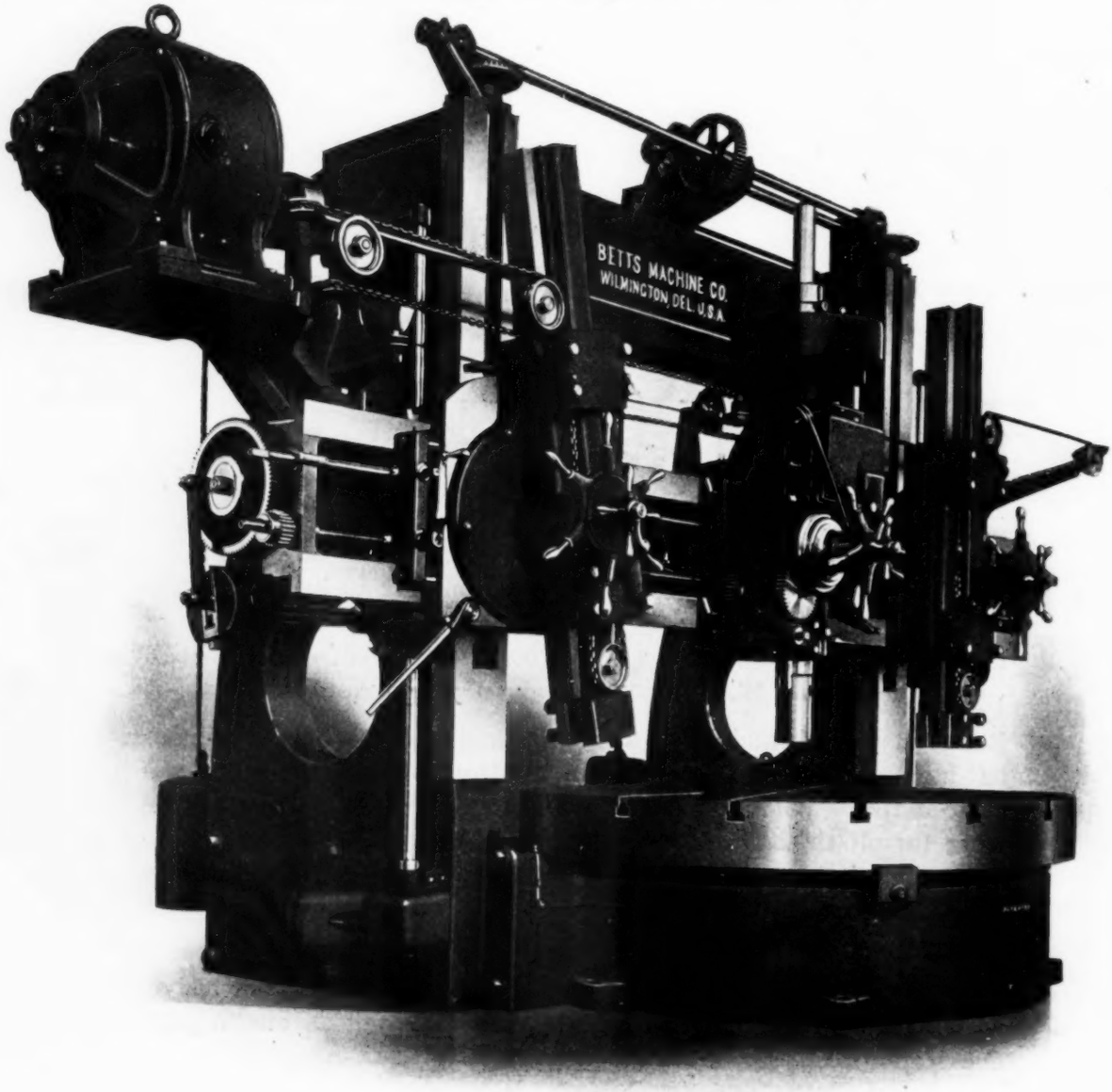
Betts Machine Company

Wilmington, Del., U. S. A.

Makers of

Heavy Machine Tools

For High Speed Steel



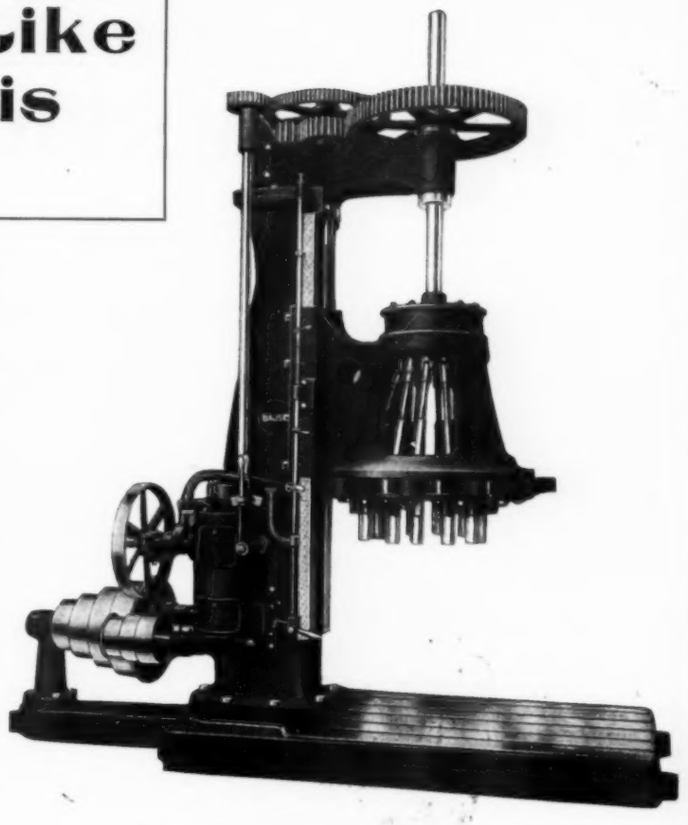
The BETTS 8 ft. Boring and Turning Mill, showing the motor-driven Central Boring Head, as made for the Frick Company, Waynesboro, Pa.

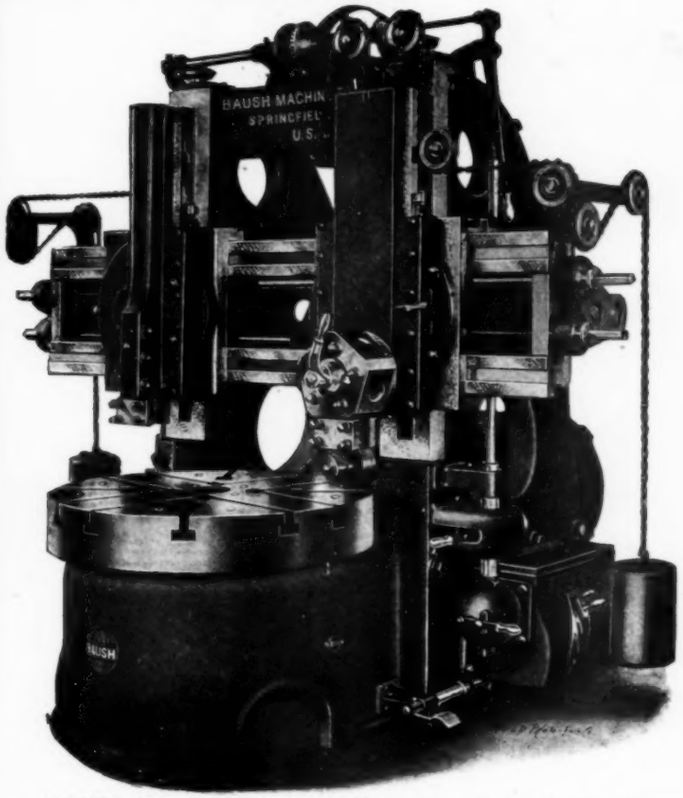
Vertical Boring Mills, Horizontal Boring Machines, Slotting Machines, Planing Machines, Floor Borers, Tire Mills, Etc., Etc.

Would You Like To Drill This Way ?

The Baush Adjustable Multiple Spindle Drill provides for drilling from 2 to 20 holes at once in a layout of any shape up to 46" diameter. The holes are made with great speed and perfect accuracy. For drilling jobs in duplicate there is no equal to the Baush Drill.

Ask for Bulletins.





For Rapid Production

Baush Boring Mills embody every feature which practical test has shown to aid in the fast production of accurate work in large quantities.

Baush Mills are cost reducers. Look at our big, powerful 42" motor driven mill, illustrated. Drive is directly into table, table bearings are the broadest made and all steel gears are regularly furnished.

We can't do *justice* to Baush Mills here. Write for our free catalog and study the sizes, from the 30" to the 61".

Baush Machine Tool Co.
640 Wason Avenue.
Springfield, Mass., U.S.A.

AGENTS—Manning, Maxwell & Moore, New York, Chicago, Milwaukee, Boston, Cleveland, Pittsburg, St. Louis, Philadelphia, Detroit, Buffalo, Syracuse, Atlanta, Yokohama. De Fries & Cie, Düsseldorf; Selig-Sonnenthal & Co., London; Hugo Tillquist, Stockholm. Fenwick, Freres & Co., Paris, France.

THE "AMERICAN" WAY

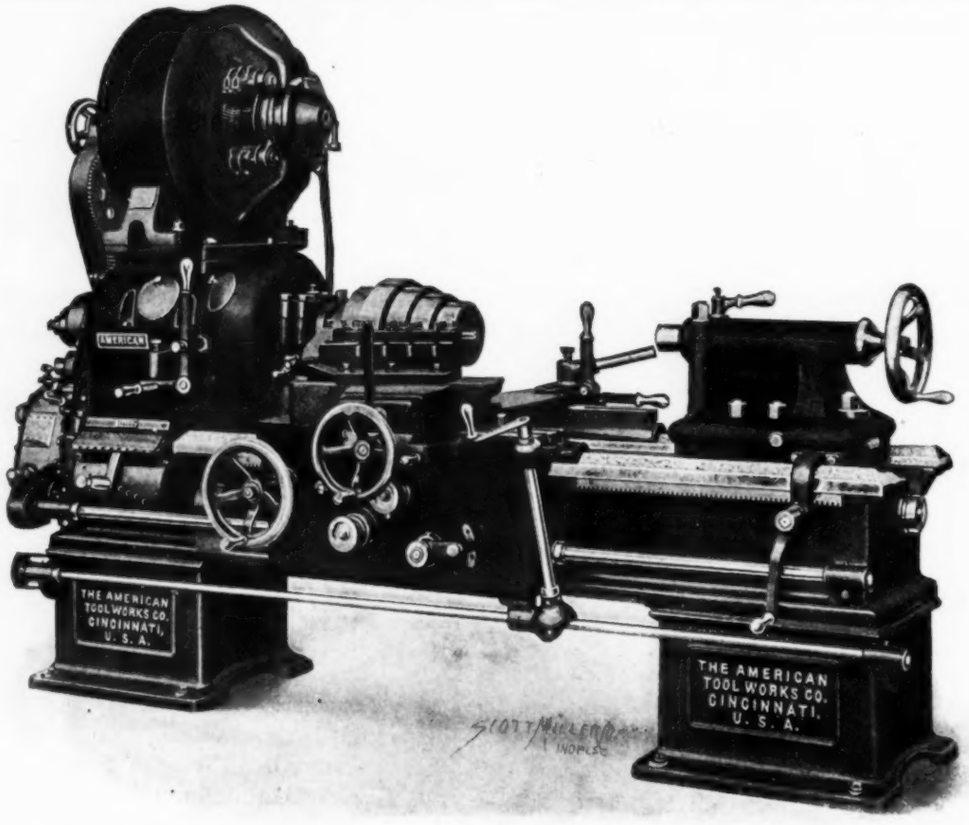
The 24-inch American Geared Head Lathe, shown below, equipped with Multiple Tool Rest and Crowning Device, is possessed of such ENORMOUS POWER that all steps of the cone pulley, being worked upon, are ROUGHED—FACED—CROWNED—FINISHED, consecutively, at ONE SETTING OF THE TOOL, resulting in the following remarkable reduction of shop cost on the job.

OLD TIME 160 Min.

This Great Power is Worth Much to You

THINK IT OVER

NEW TIME 38 Min.

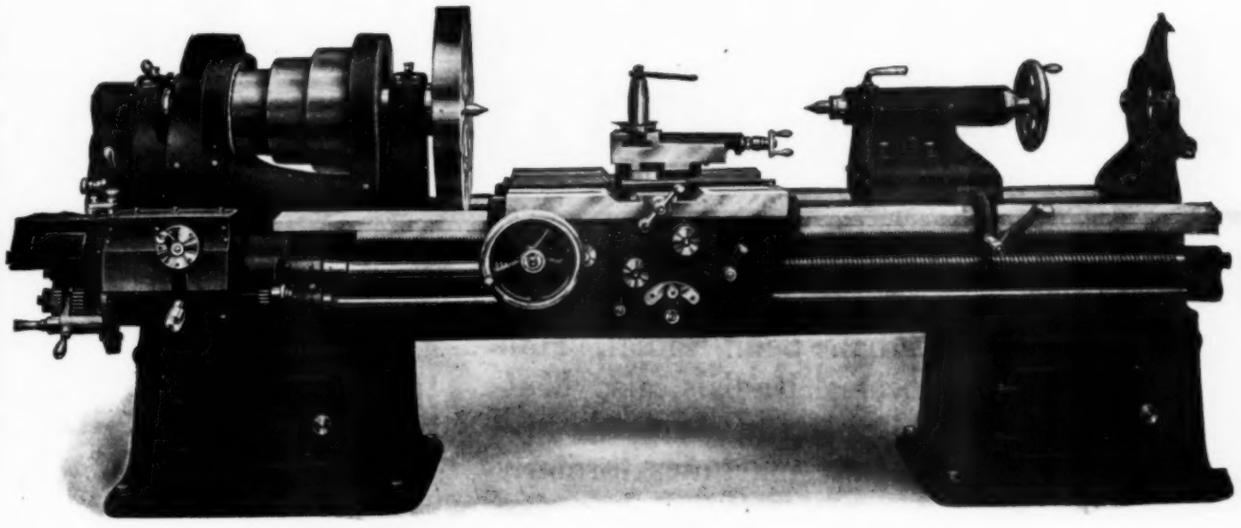


THE AMERICAN TOOL WORKS CO.

CINCINNATI, U.S.A.

LATHES-PLANERS-SHAPERS-RADIAL DRILLS.

24-Inch Double Back Geared Instantaneous Change Gear Engine Lathe With Double Plate Apron.



ENGINE LATHE 18 to 48 INCH SWING

SCHUMACHER & BOYE

CINCINNATI, OHIO, U. S. A.

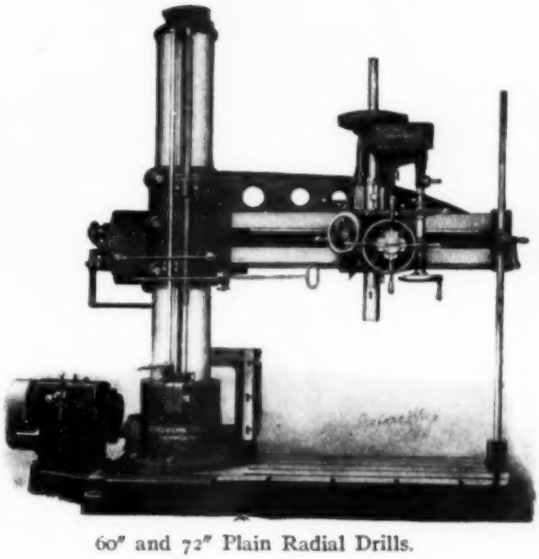
AGENTS—Manning, Maxwell & Moore, Inc., New York City, Chicago, Boston, Philadelphia, Syracuse, St. Louis, Atlanta; The Baird Machinery Co., Pittsburg, Pa.; The Strong, Carlisle & Hammond Co., Cleveland, O., and Detroit, Mich.; F. W. Cook, Spokane, Wash.; The Perine Machinery Co., Seattle, Wash.; Pacific Coast Mfg. Co., Los Angeles, Cal.; Henshaw, Bulkley & Co., San Francisco; Kellogg & Co., Toronto, Ont.

Time And Tool Saving Radial Drills

They are simple in construction but embody every valuable feature known.

There are six changes of geared feed which can be varied while drilling. Spindle has automatic stop and depth gauge.

The quick return has four operative levers.



60″ and 72″ Plain Radial Drills.

Speed variator has seven changes all obtained by one lever.

Tapping attachment has a device for saving taps which increases the life of them three-fold.

Built in all sizes—Plain, Half and Full Universal.

Cone Speed Variator or Motor Driven.

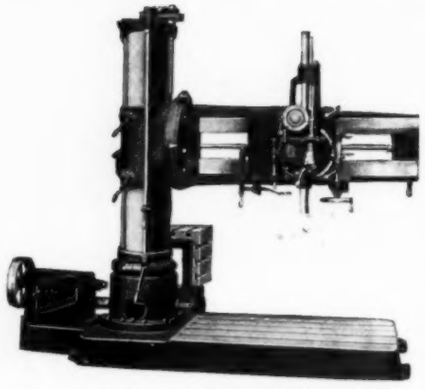
DRESES MACHINE TOOL COMPANY, CINCINNATI, OHIO.

REPRESENTATIVES:—Manning, Maxwell & Moore, Inc., New York, Boston, Philadelphia, Chicago, Detroit, Birmingham, Mexico City, Mexico, and Yokohama, Japan; Carey Machinery and Supply Co., Baltimore; Baird Machinery Co., Pittsburg; Wm. C. Johnson & Sons Machinery Co., St. Louis; The Strong, Carlisle & Hammond Co., Cleveland; Pacific Tool and Supply Co., San Francisco; Selig, Sonnenthal & Co., London; C. Schinz, St. Petersburg; G. Koeppen & Co., Moscow; Wilh. Sonesson & Co., Malmo and Stockholm, Sweden; Van Rietschoten & Houwens, Rotterdam; V. Lowener, Copenhagen and Christiania; Stiasi & Zweifel, Milan, Italy; Alfred Herbert, Ltd., Paris, Belgium, Spain and Portugal; E. Sonnenthal, Jr., Berlin and Köln; White, Child & Beney, Vienna; Shewan Tomes & Co., Shanghai, Pekin and Canton; Castle Bros., Wolf & Sons, Manila.

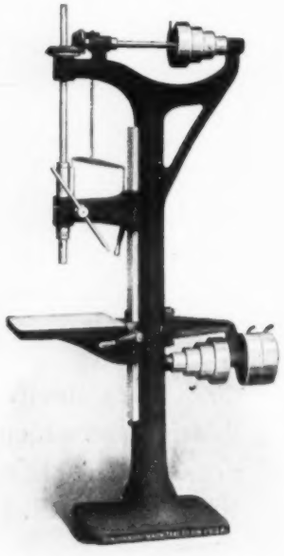
Metal Drilling Machinery

THE largest and most complete line of Upright, Radial, Semi-Radial, Half and Full Universal Radials, also Multiple Drills, Gang Drills and Tapping Machines, consisting of the machines formerly furnished by

Cincinnati Machine Tool Co.
The Bickford Drill & Tool Co.



The Bickford Universal Radial Drill.



The Cincinnati High Speed Drill.

Bickford Radial Drills are made in six sizes and twenty-four styles, the sizes ranging from 2½ to 6′. These machines are furnished with three styles of drive, cone, gear and motor, and with any style of table, such as box, swinging or swiveling.

The design of these machines is simple. They are rigid in construction, easily manipulated, have durability of wearing parts and will produce a volume of output and accuracy of work greater than any other drill on the market.

The Cincinnati line of Upright Drills consists of machines ranging from 20″ to 42″ and these machines can be furnished in every possible construction used in Upright Drill building. The Patent Geared Tapping Attachment on the Cincinnati Upright Drills is located directly on the spindle and is the most perfect attachment of this kind ever made. It can be completely disengaged when no tapping is to be done.

One feature found on the Cincinnati Upright Drills and on no others is an instantaneous stop for the spindle without stopping the machine to make changes of chuck or drills.

The Cincinnati Bickford Tool Company

Cincinnati, Ohio, U. S. A.

DOMESTIC AGENTS—Prentiss Tool and Supply Co., New York, N. Y., Boston, Mass., Buffalo and Syracuse, N. Y.; W. E. Shipley Machinery Co., Philadelphia, Pa.; Brown & Zortmann Machinery Co., Pittsburg, Pa.; Motch & Merryweather Machinery Co., Cleveland, Ohio, and Detroit, Mich.; Marshall & Huschart Machinery Co., Chicago, Ill., Indianapolis, Ind., St. Louis, Mo.; Robinson, Cary & Sands Co., St. Paul and Duluth, Minn.; Hallidie Machinery Co., Seattle and Spokane, Wash.; Zimmerman, Wells, Brown Co., Portland, Ore.; Harron, Rickard & McCone, San Francisco and Los Angeles, Cal.; Utah Mining Machinery and Supply Co., Salt Lake City, Utah; C. T. Patterson Co., Ltd., New Orleans, La.; M. E. Dewstoe, Birmingham, Ala.; Morrison Machinery and Supply Co., Richmond, Va.

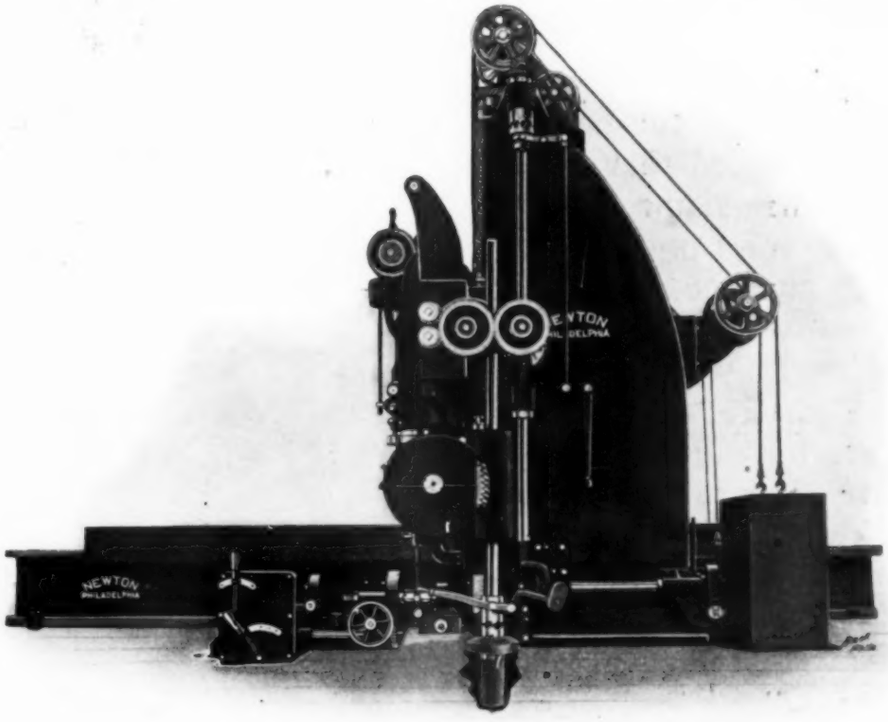
NEWTON

(Registered Trade Mark.)

Slotting Machines
Crank Driven 6" to 20" Stroke
Gear Driven 24" to 73" Stroke
Portable Machines 36" to 96" Stroke

Cold Saw Cutting-Off Machines
Bar, Crank-Shaft
I-Beam, Combination and
Steel Foundry Types

The Sixth of a series of illustrations making comparison in output and design.



Heavy, Four-Spindle Milling Machine.

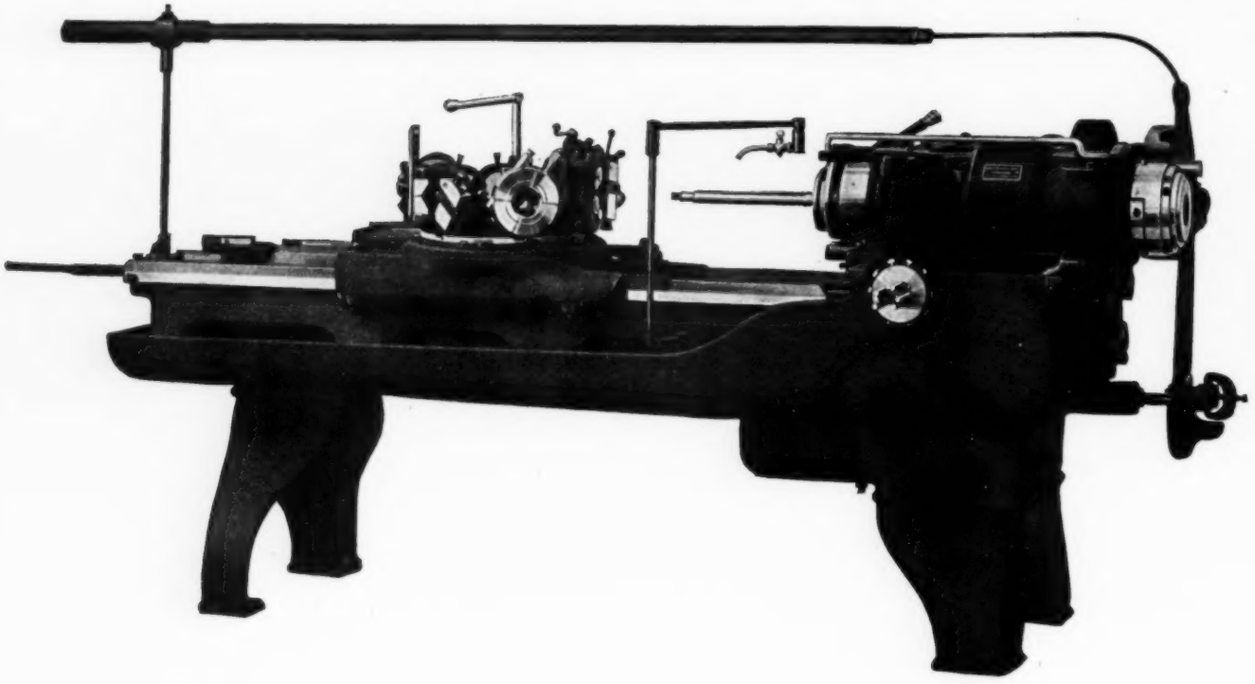
Above illustration shows concentration of levers of control.

Work table has spiral gear and rack feed and fast traverse (in both directions). Independent clutched drives are furnished for operation of the side head drive, the cross-feed to saddles on rail and the rail elevating mechanism

NEWTON MACHINE TOOL WORKS, INC.,

PHILADELPHIA, U. S. A.

FOREIGN REPRESENTATIVES:
Berlin, Heinrich Dreyer. Vienna, Rudolf Salzer. Italy, Spain, Switzerland, Belgium and France, Fenwick, Freres & Co., Paris.



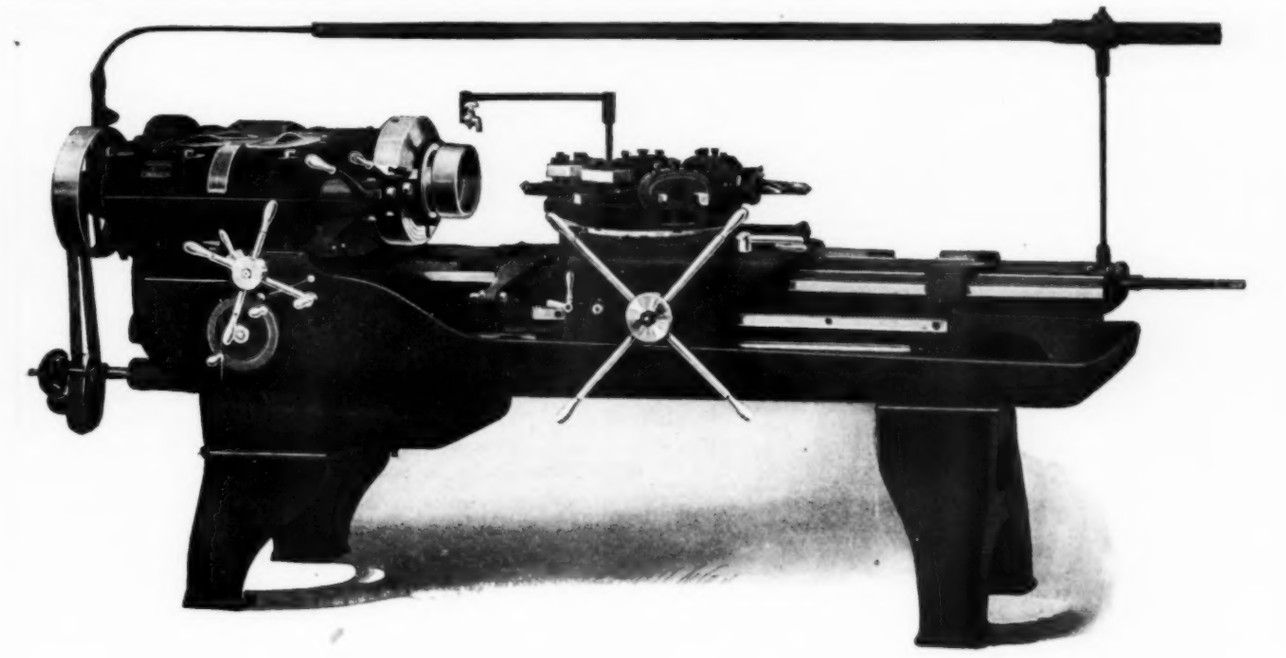
The Flat Turret Lathe For Bar Work

If you have reached the point where you are convinced that it is the "adaptable" turret lathe, hand operated, that you want in order to get out any piece any time, and get it out in larger or smaller lots (yet you are bewildered by the claims made for the "just-as-good" machines which are out for our business), let us give you a few pointers which will make it possible for you to settle the question in your own mind.

If you cannot see a sample of each machine running (and by the way, the others are hard to find) then take the cut of each machine and see how readily you can pick out the original machine—the one that was designed on the natural lines—and then see the others that were compelled to take the next best way.

The original accomplishes all its ends by the simplest and most direct means.

Jones & Lamson Machine Company,



The Flat Turret Lathe For Chucking Work

In buying turret machinery remember that any machine that requires a lot of special tools for your work will require a lot more when there is a slight change in it. Such machines cannot be changed from one kind of work to another without weeks, and sometimes months, of delay.

The expensive tools which you buy with such machines will be obsolete in a short time—if you doubt it, go into your own or some other plant where these machines have been used a few years, and see the out-of-date tools.

If the "just-as-good" turret lathes, offered in competition with ours, are said to possess a standard set of tools, look sharp as to the character of these tools. You'll probably find them weak and unreliable under stress, or very inconvenient in adjustment, or both.

Send for "The Hartness Flat Turret Lathe."

Springfield, Vermont, U.S.A., and 97 Queen Victoria St., London.

Germany, Holland, Belgium, Switzerland and Austria-Hungary; M. Koyemann, Charlottenstrasse, 112, Düsseldorf, Germany. France and Spain: Ph. Bonvillain and E. Ronceray, 9 and 11, Rue des Envierges, Paris, France. Italy: Adler & Eisenschitz, Milan.

LIST PRICE
$100.00

THIS cut represents our No. 5 Screw Cutting Lathe. Swings 11 inches on face plate, 34 inches and 40 inches between centers; has swivel tool carriage and is adapted to taper turning and boring. Compound rest and raising blocks extra. Stand-up treadle or countershaft if desired. **List Price, $100.00.**

LIST PRICE
$75.00

OUR No. 4½ Lathe is identical in construction with the No. 5 Lathe, except of smaller dimensions. It swings 9 inches over face plate and 25 inches between centers. Has set-over tailstock, swivel tool carriage for taper boring and turning. For experimental, electrical and repair work this tool is unsurpassed. Countershaft or stand-up treadle power furnished if desired.

Our No. 5½ Lathe swings 13 inches over face plate and is made in different length beds up to 10 feet long.

Our No. 13 Lathe swings 13 inches over face plate and has automatic cross-feed and compound rest; made in different length beds up to 10 feet long.

Send For Catalog

TRADE W.F. AND J.B. MARK

W. F. & JOHN BARNES CO.,

England by Chas. Churchill & Co., London.

1995 Ruby St., ESTABLISHED 1872 ROCKFORD, ILL., U. S. A.

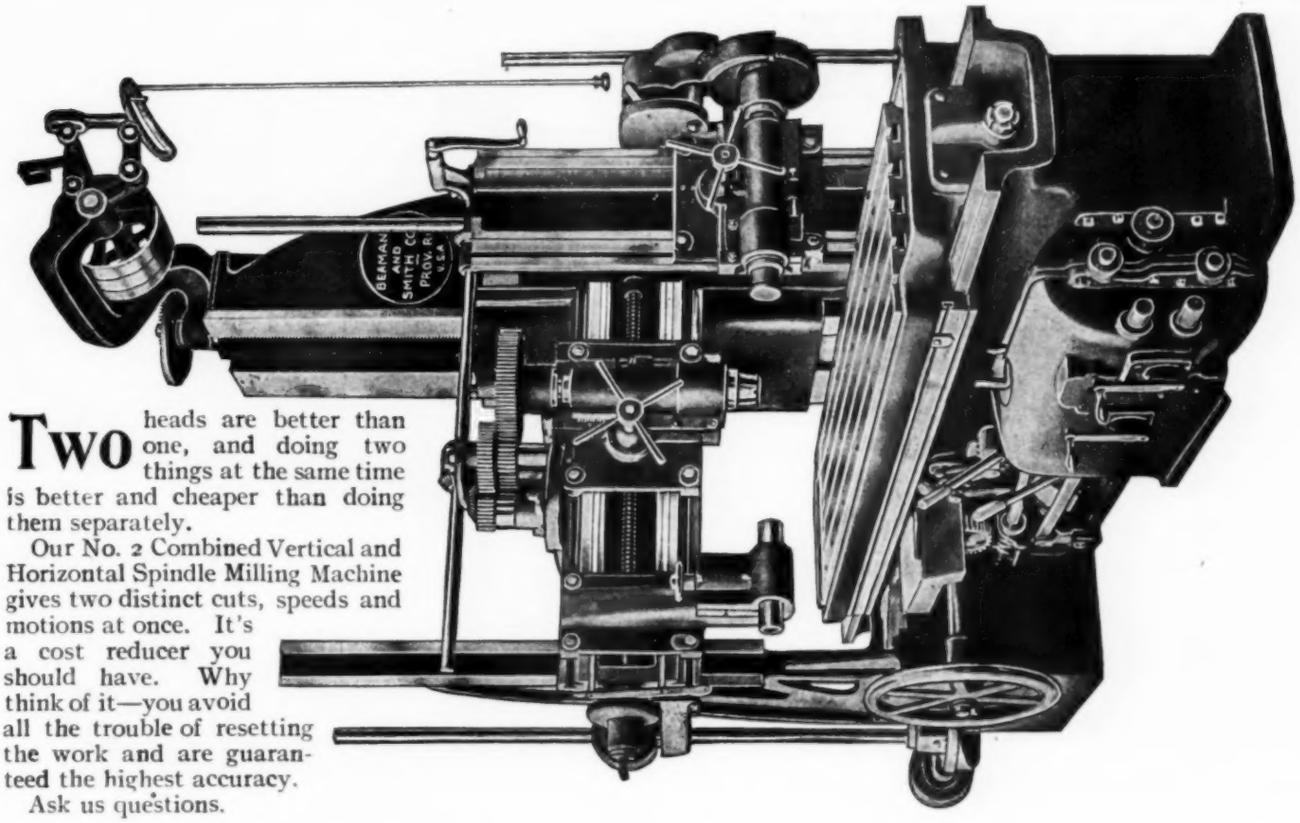
Speeds of 15 to 50 Feet A Minute Are Obtained On "CINCINNATI" Variable Speed Planers

Thus providing the exactly right and most highly profitable speeds for roughing and finishing, and for cast iron, steel and brass. The saving over the one-speed method is 25 to 50%.

Write for Catalog.

THE CINCINNATI PLANER COMPANY,
CINCINNATI, OHIO, U. S. A.

Belt or Motor Drives
Sizes from 22″ to 84″



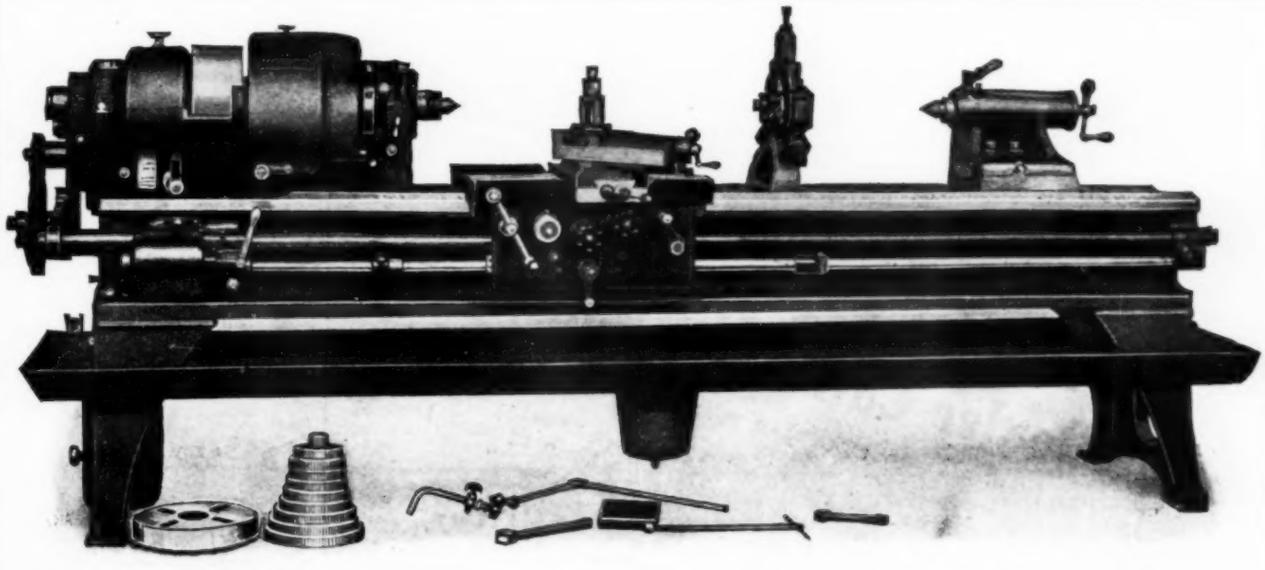
Two heads are better than one, and doing two things at the same time is better and cheaper than doing them separately.

Our No. 2 Combined Vertical and Horizontal Spindle Milling Machine gives two distinct cuts, speeds and motions at once. It's a cost reducer you should have. Why think of it—you avoid all the trouble of resetting the work and are guaranteed the highest accuracy.

Ask us questions.

The Beaman & Smith Co., Providence, R. I., U. S. A.

England: Chas. Churchill & Co., London. France: Fenwick Freres & Co., Paris. Germany: Ludw. Loewe & Co., Berlin.



Note The Strength Of The Outline

Our No. 3 High Power Rapid Production Lathe is improved to the minute, and users fail to suggest a single point that could be bettered. The operator is always in complete control and has instant access to 6 changes of feed. Write for circular 124 and study this profit producer at closer range.

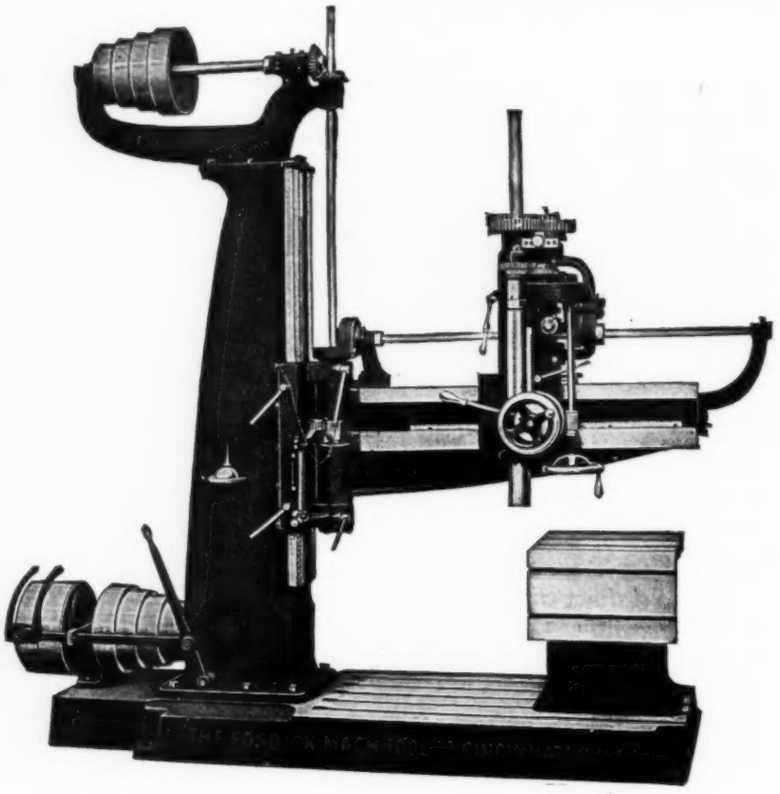
The Springfield Machine Tool Co., Springfield, Ohio, U. S. A.

Ing. Vaghi Accornero & Co., Agents for Italy. Ludw. Loewe & Co., Berlin, Germany Agents.

FOSDICK

Features Lead To Profit

Fosdick Radials have the strength, rigidity, speed and ease of operation that allow them to produce accurate holes at the most highly profitable speed. They are made in sizes from 2-ft. to 8-ft. arms.



The Fosdick Machine Tool Co.,

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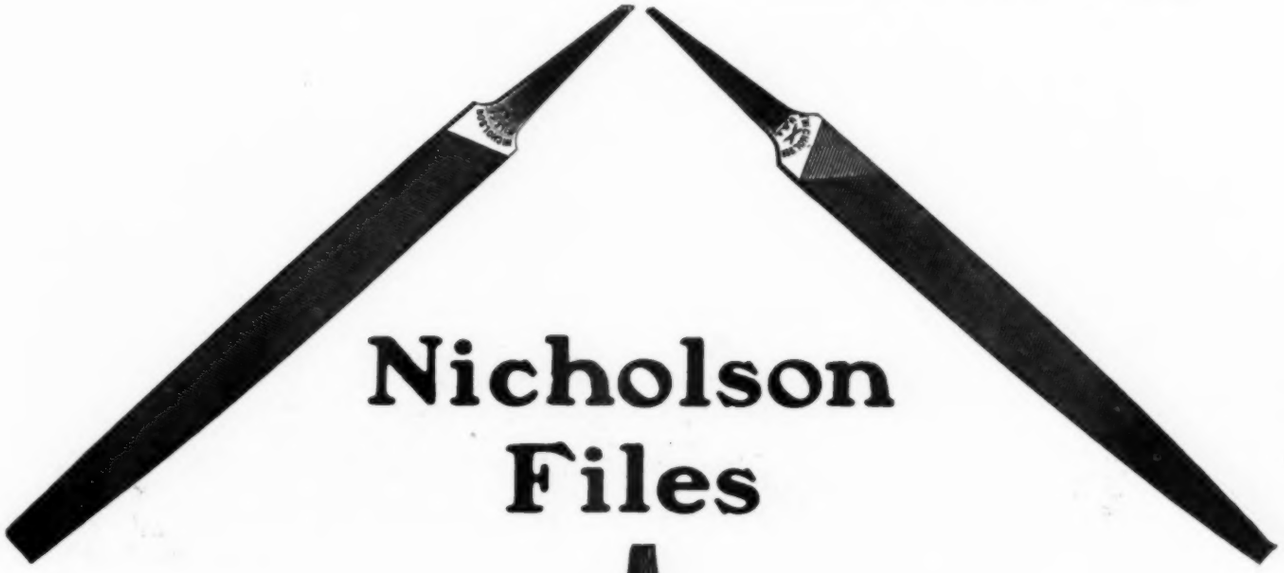

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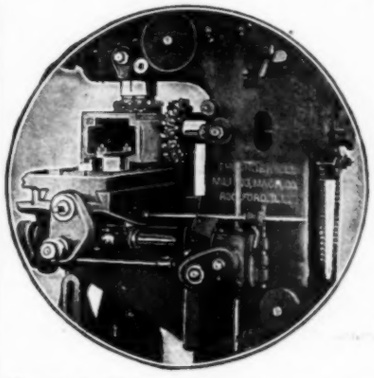

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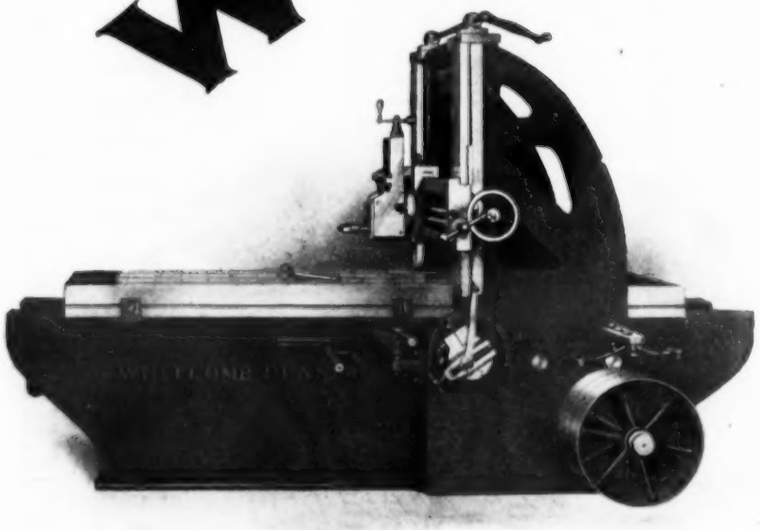

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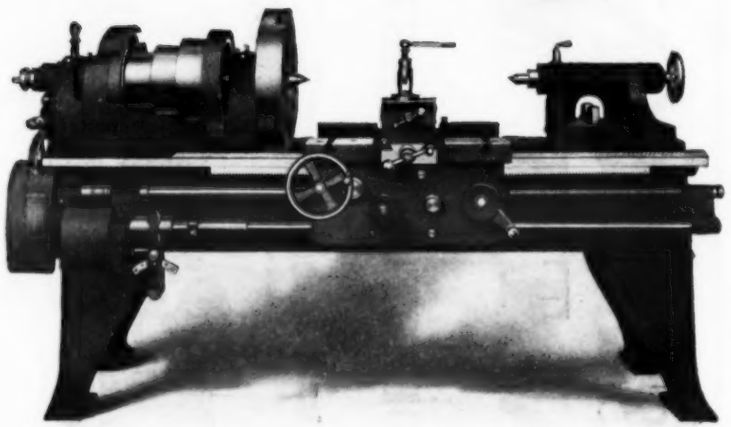

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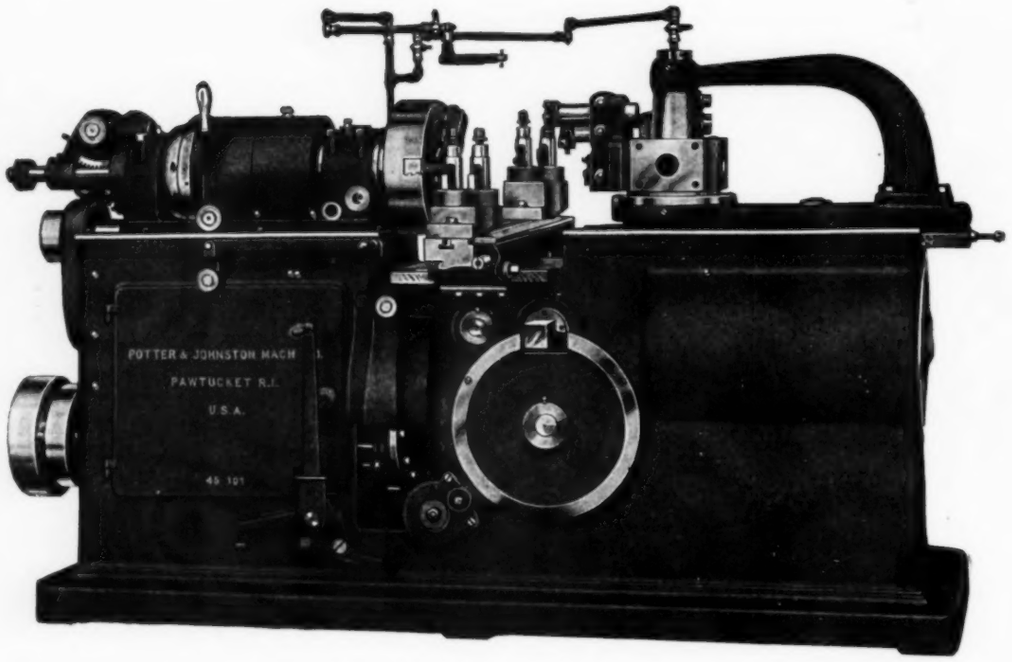

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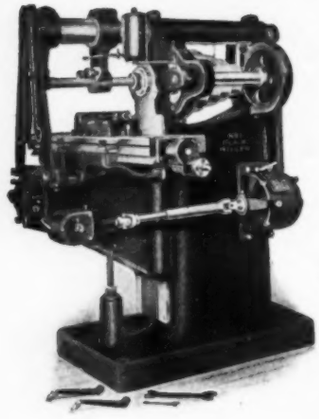

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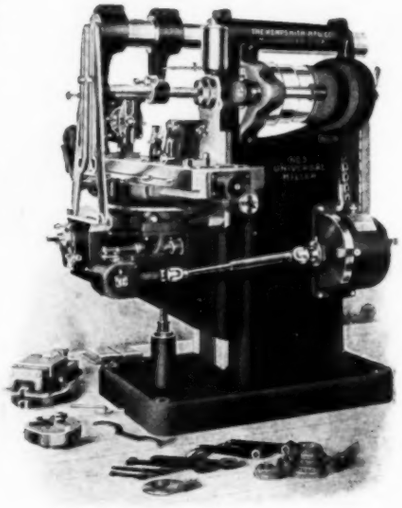

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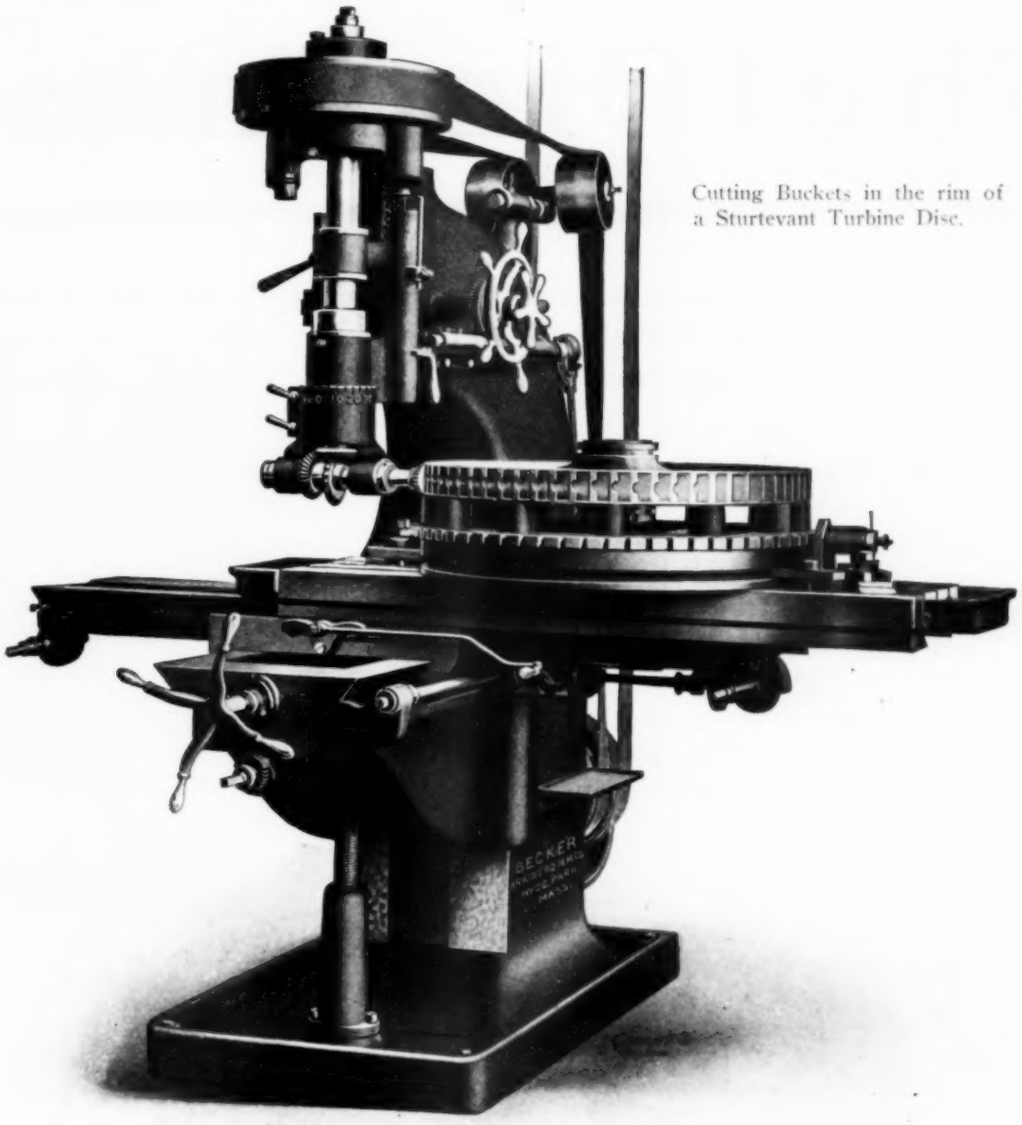

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The Cincinnati

Cincinnati High Power Millers can be supplied with any one of four styles of main drive. A change from the one in use to any other can be made at any time by the user in his own shop.

The STANDARD DRIVE is shown in Fig. 1.

The pulley runs on a bracket independent of the shaft, which is thus relieved of the belt pull. All shafts are extremely large for the service required and none undergo combined torsional and bending strains. The tumbler gear frame is firmly clamped, automatically, to the machine frame, at each position. There are never any gears running idle.

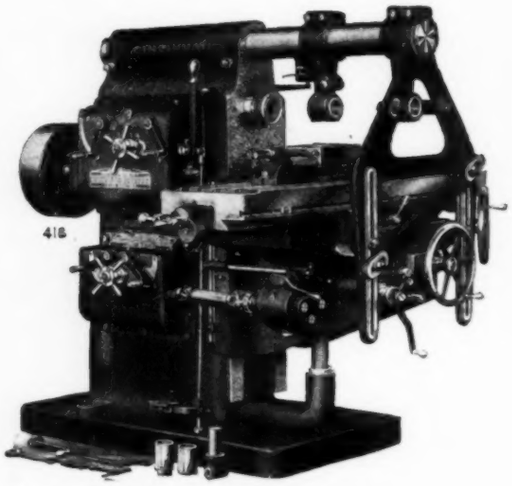

Fig. 1. The Standard Drive

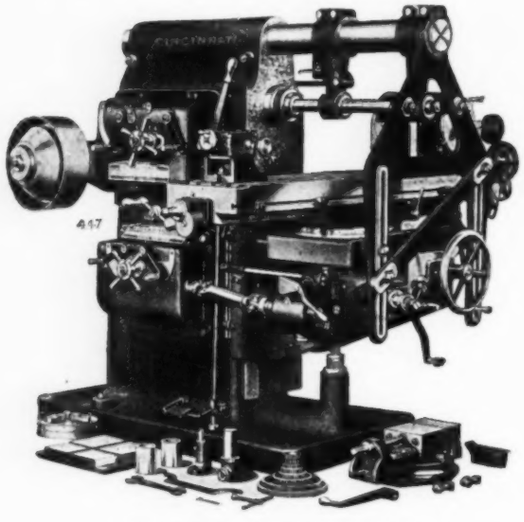

Fig. 2. The Right Angle Drive
It can be applied at any time

The RIGHT ANGLE DRIVE is shown in Fig. 2.

It permits setting the machine at right angles to the line shaft to get better light, or to facilitate handling material. To change from the Standard Drive to this, simply requires an interchange of driving boxes.

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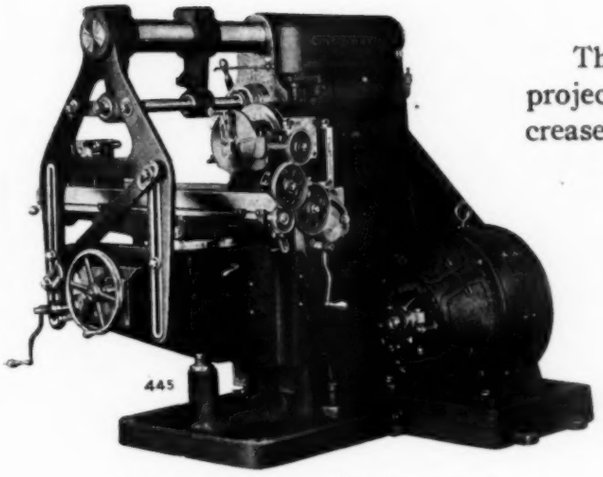

Fig. 3. The Motor Drive Arrangement

The CONSTANT SPEED MOTOR DRIVE, rear, is shown in Fig. 3.

The motor is mounted on the base; does not project beyond the line of the machine; does not increase floor space. The driving chain runs at a moderate speed and is entirely covered. Any standard motor running at a constant speed between 600 and 1800 rev. can be used. To change from the Standard Drive to this, simply requires substitution of chain wheel for pulley and adding motor base.

The VARIABLE SPEED MOTOR DRIVE is shown in Fig. 4.

It takes a 2 to 1 motor mounted as above. The field rheostat takes the place of pilot wheel, tumbler, and some gears in the drive box. To change from the Standard Drive to this, simply requires an interchange of drive boxes and the addition of the motor base.

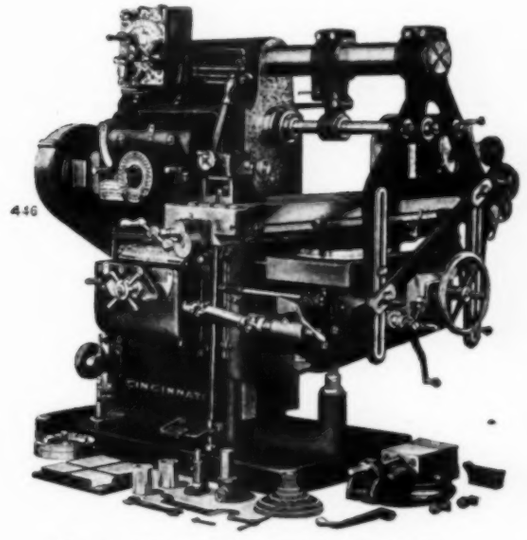

Fig. 4. The Variable Speed Motor Drive

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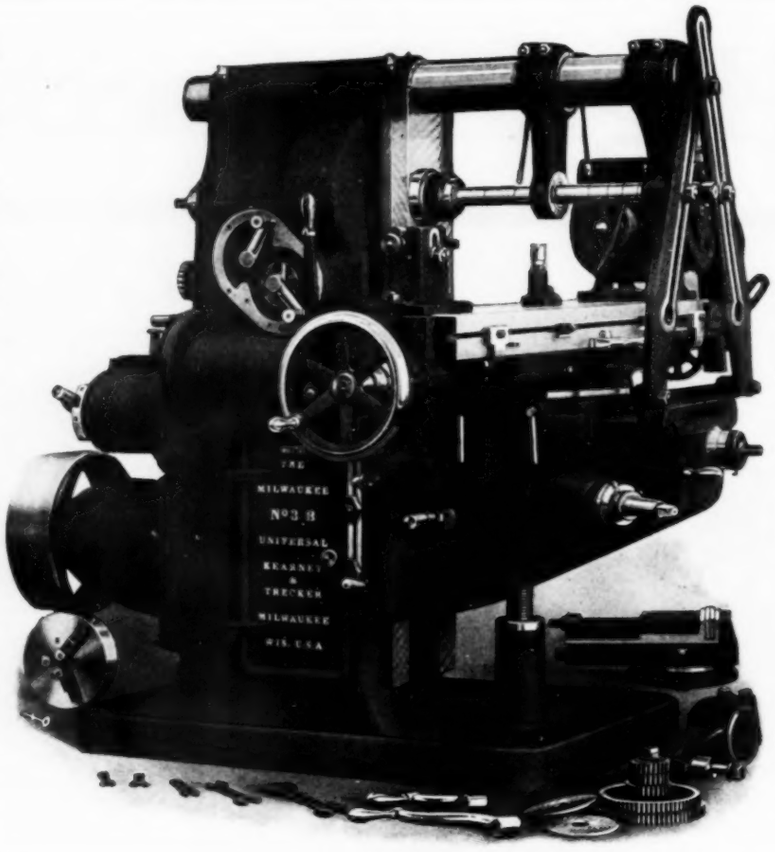

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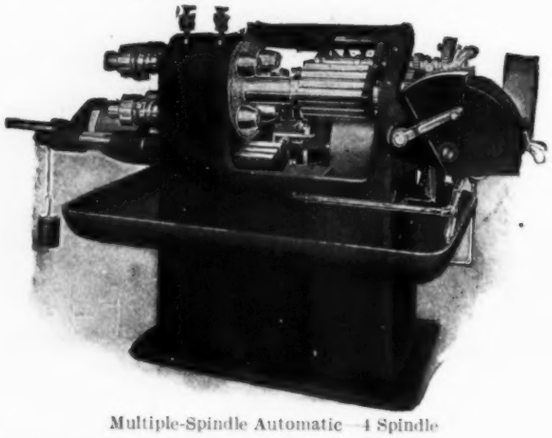

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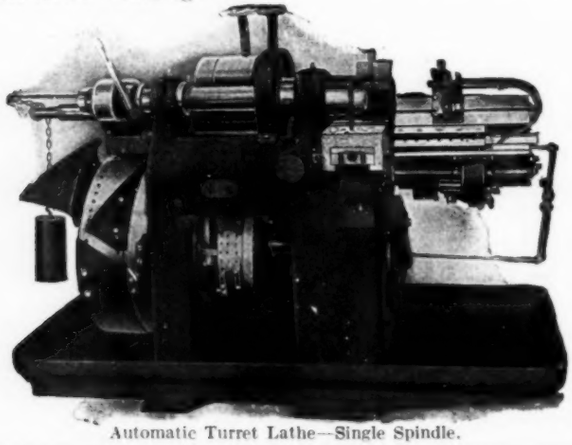

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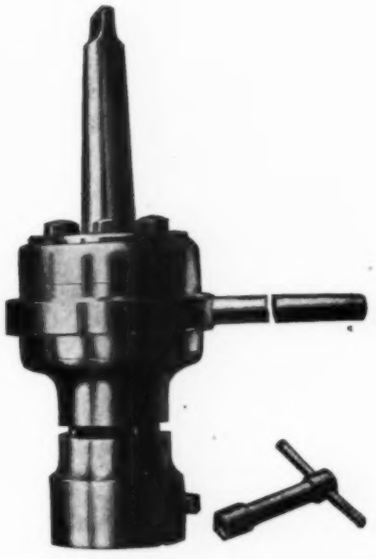

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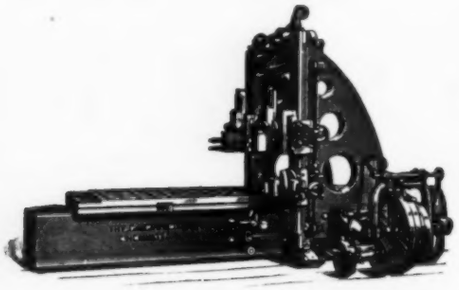

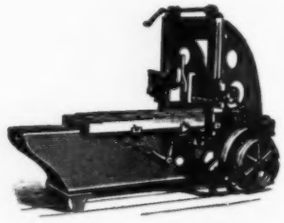

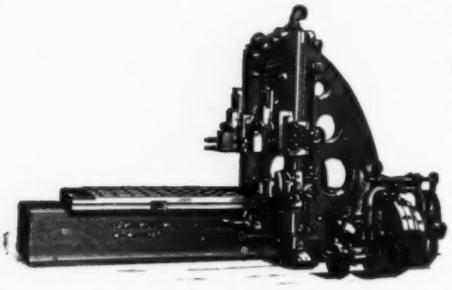

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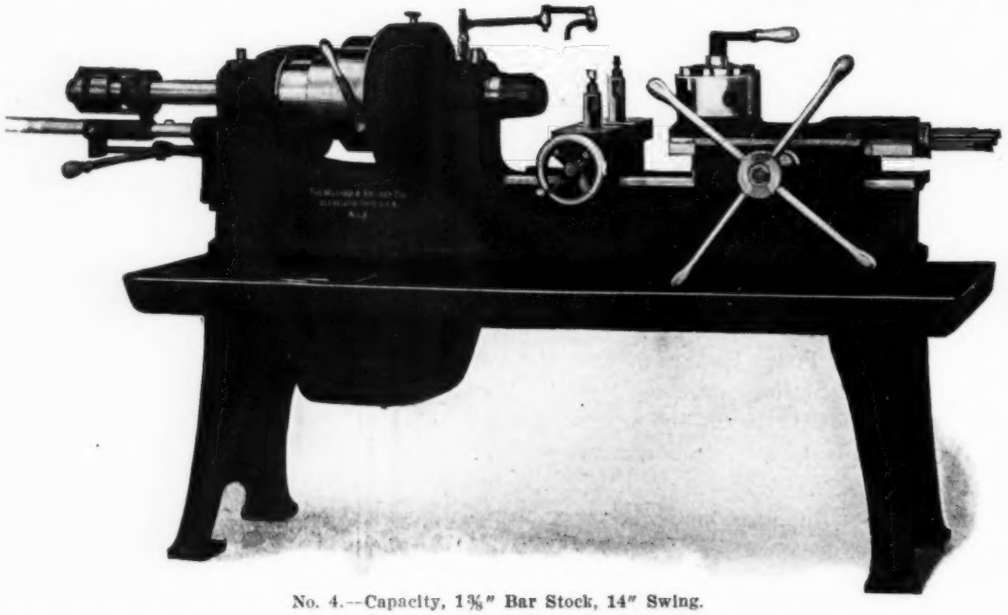

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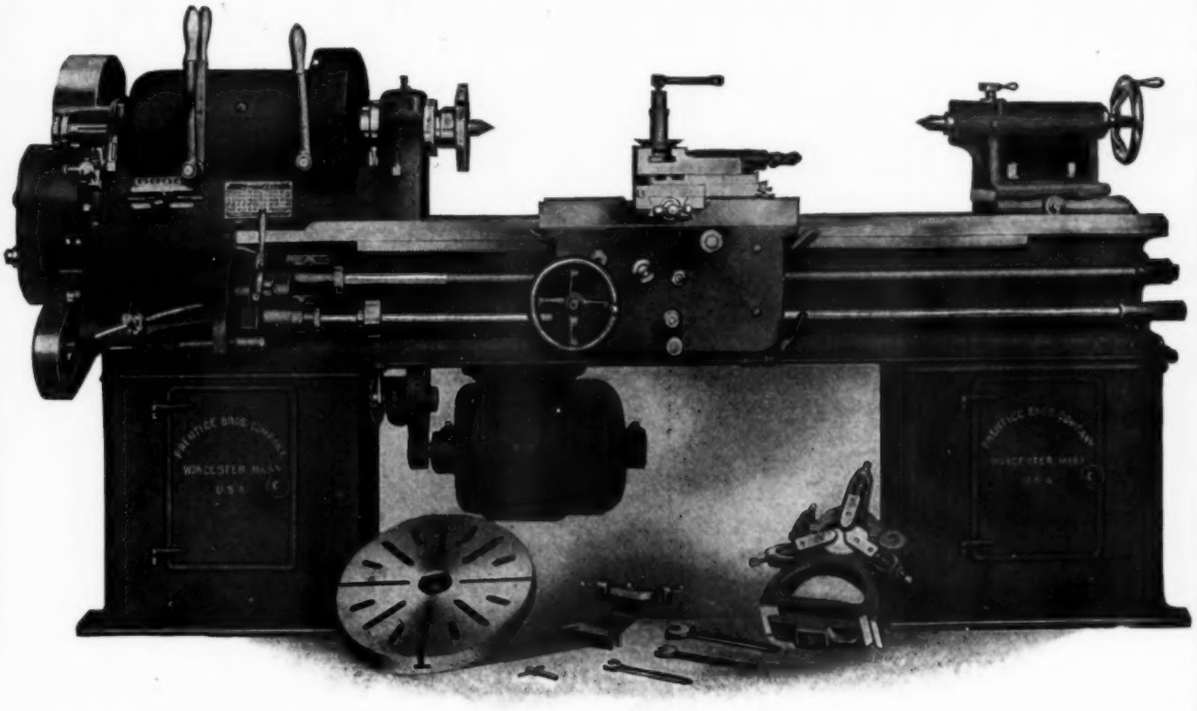

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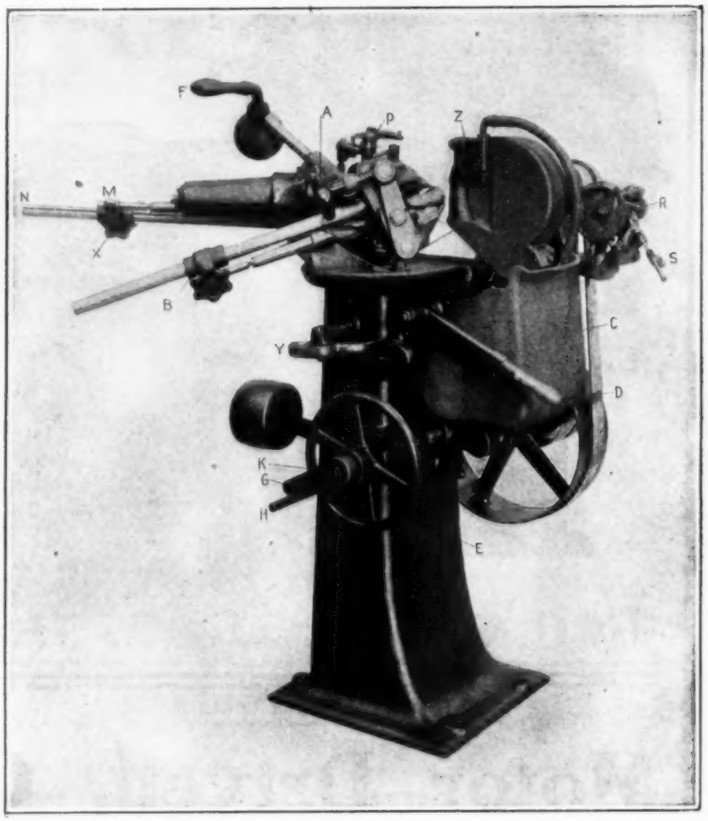
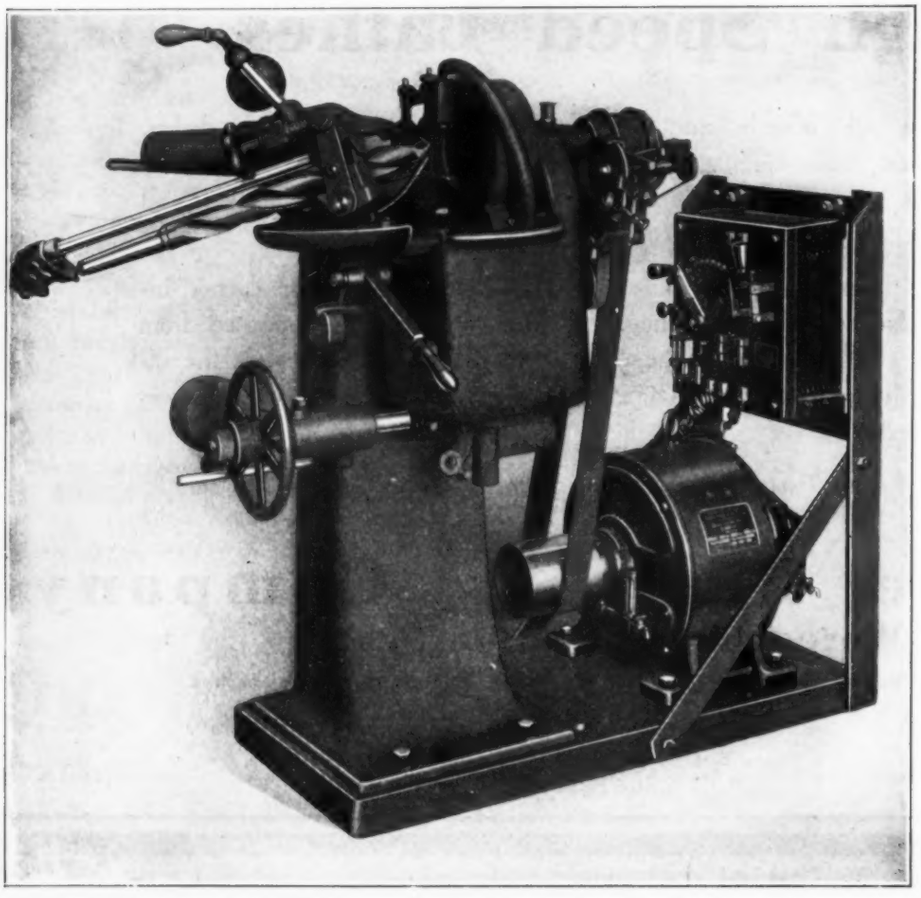


OUR DRILL GRINDING AND POINTING MACHINE

is a notable example of the above class of tools



For twist and flat drills from $\frac{1}{8}$" to 3" diameter inclusive.

Grinds the proper amount of clearance to every part of the cutting edge of the lips.

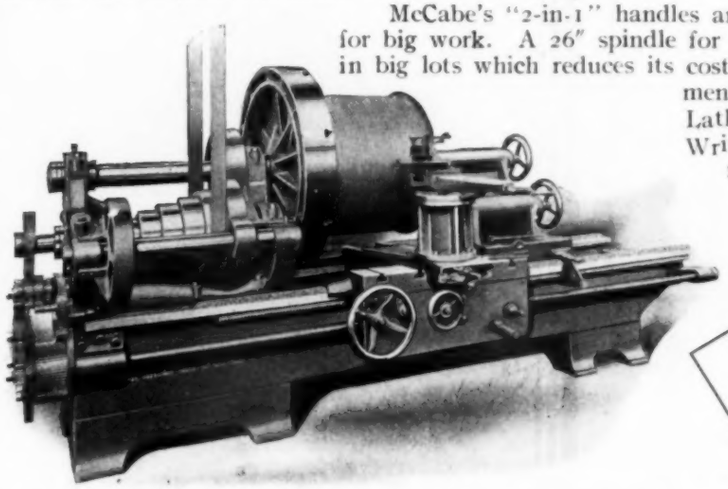
Does not require a mechanic to grind a perfect drill.

Drills ground and pointed by this machine will do more and better work before regrinding is necessary, require less power of feed and cut faster, than when sharpened in any other way.

Let Us Take Your BIG Lathe Out In Trade

What's the use of allowing it to camp out permanently in your shop if you haven't enough work to keep it busy. We'll accept it in trade and in its place you can put McCabe's "2-in-1" Double Spindle Lathe—the tool that's always busy on big, medium or light work.

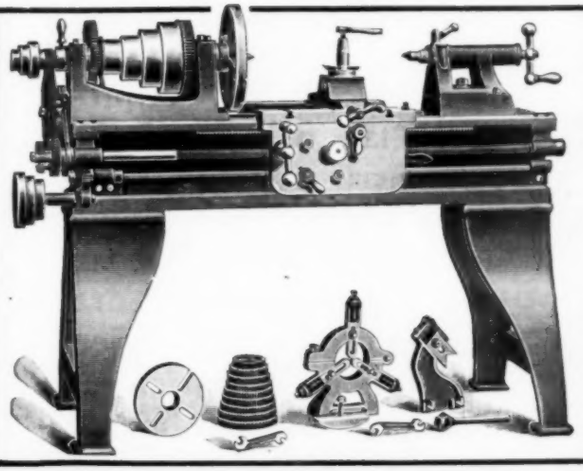
Don't look in the 2nd-hand market for a McCabe's "2-in-1," for you won't find one there. Owners are too wise to part with them. So come to headquarters.



McCabe's "2-in-1" handles any size job, any time. A 48" spindle for big work. A 26" spindle for light work. A system of manufacture in big lots which reduces its cost. An accuracy like that of Government tools—for McCabe's "2-in-1" Lathes are made the same way.

Write *at once*—which means now—for a Catalog.

J. J. McCabe,
Hudson Terminal,
30 Church St., New York City.



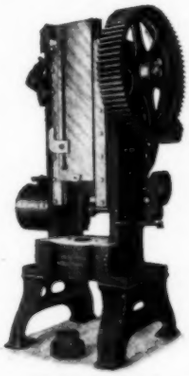
Handle Medium And Small Work Correctly

Handling it correctly, doesn't mean throwing it on a Big Lathe. You wouldn't use a pair of ice tongs to pick up a needle. Neither should you compel your big expensive lathe to waste its time and power on small work.

The Sebastian 15" comes closest to the "big ones" in lines of weight and rigidity. It is accurate, high grade and low priced. *Catalog?*

Sebastian Lathe Company,
117-119 Culvert St., Cincinnati, Ohio, U. S. A.

Foreign Agents:—C. W. Burton, Griffiths & Co., London; E. Sonnenthal, Jr., Berlin, Cologne, Vienna; Nienstaedt & Co., Copenhagen; Jno. Tragardh & Co., Gothenburg; A. Baldini & Co., Pontedea, Italy; F. W. Horne, Yokohama.



REDUCING PRESS NO. 60.

"BLISS"

PRESSES, DIES, DROP HAMMERS, DOUBLE SEAMERS, SHEARS AND SPECIAL MACHINERY

Heavier and stronger than any other press built for the same purpose. Stroke adjustable from 4" to 36". Speed may be adjusted to suit work. It is especially intended for drawing shells and tubes up to 18" in length.

Write for Circular.

E. W. BLISS COMPANY, 1 ADAMS STREET, BROOKLYN, N. Y.

European Office: 100 Boulevard Victor-Hugo, St. Ouen (Paris), France.
London Office: 114 Queen Victoria St., London, E. C., England
Representatives for Chicago and Vicinity: Stiles-Morse Co., 67 West Washington St., Chicago, Ill.

If You Want Tools As Permanent As Your Machines Try

CARD TAPS

The name "S.W. Card" on a tap is a positive guarantee of perfect accuracy and highest quality. The material, the temper, the workmanship, the inspection —all have been brought to the highest degree of perfection in the Card factory. One trial is proof enough.

Order from our free catalog

S.W. Card Mfg. Co.

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EUROPEAN AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow: Markt & Co., Ltd., Paris; Fenwick Freres & Co., Milan; Ignacz Szekely, Budapest; V. Lowener, Stockholm, Copenhagen, Christiana. A. A Kampfraath (Brussels), Ltd., Brussels; Hans Schulze, Brünn, Austria.

WHEN IT IS HOT

and it seems impossible to get a breath of fresh or pure air—

REMEMBER

that overheated air can be removed at slight expense by an electric fan. A propeller fan will do if the volume is large and resistance slight. For piping use a cased fan. The fan can be placed where wanted with regulating rheostat in a convenient location. A full line of electric fans is made by B. F. STURTEVANT CO.

B. F. STURTEVANT CO.,

BOSTON, MASS.

General Office and Works, Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO
CINCINNATI LONDON

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters; Rotary Blowers and Exhausters; Steam Engines, Electric Motors and Steam Turbines; Pneumatic Separators, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, etc. 718

CARBORUNDUM GRINDING WHEELS

Have reduced cost and increased efficiency in thousands of Grinding Shops all over the world.

No other grinding wheel ever did so many different kinds of work—or did any one of them with such uniform superiority.

Carborundum's great advantage over other grinding wheels lies in its extreme hardness and sharpness.

Where other abrasives *rub* or *grind*, Carborundum *cuts*.

This enables it to do, not only cleaner and better work—but much more work in a day—and to last more days before wearing out.

There are about 100,000 different grades and sizes and grits of Carborundum Grinding Wheels—

Some of these can be used economically in *your* shop.

Write us what your grinding requirements are—if Carborundum can save you money you ought to know it.

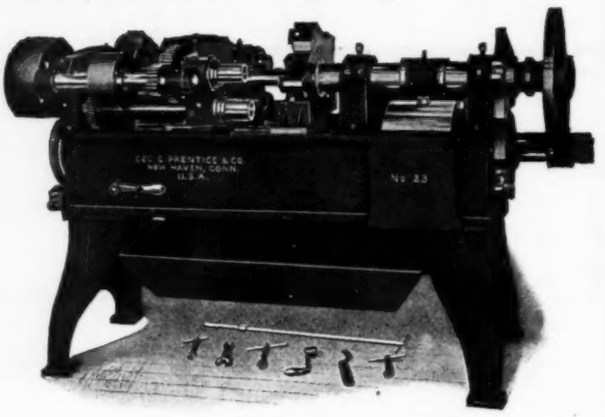
THE CARBORUNDUM COMPANY

29 Clifton Street, Finsbury Square, London, E. C., England. NIAGARA FALLS, N. Y.

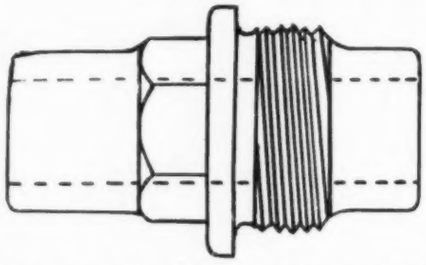
A Large Gang of Machines May Look Impressive, BUT—

a few Prentice Automatics in a corner will turn out just as much work. You're running your shop for *business*, not for looks. And Prentice Automatics save floor space and more than double your production without adding a single cent to your pay-roll. This we *guarantee*. It is a conservative claim, for as an actual fact Prentice Automatics often increase production 3 to 5 times.

Write for Catalog "C"—today.



FOUR-SPINDLE SINGLE HEAD AUTOMATIC.



What Do You Think Of This?

This Automobile Push Rod Guide (actual size, cast iron) is finished complete at one setting in the four-spindle machine. Production, 72 pieces per hour per machine. One operator tends two machines. Labor cost per 100 pieces, 11 cents. Send samples or prints of your work and find out what we can save you.

Geo. G. Prentice & Co., Inc. **New Haven, Conn., U. S. A.**

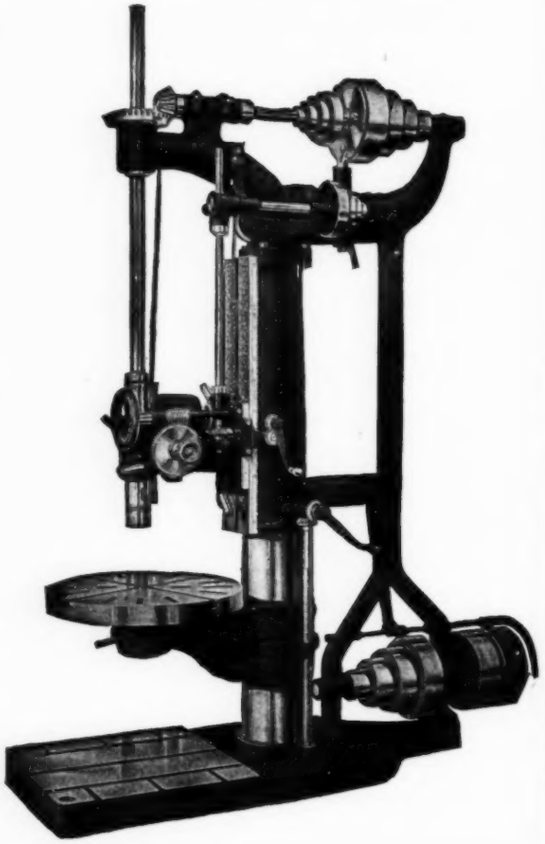
Light or Heavy Upright Drilling

is handled with utmost ease of operation and speed by one or another of the sizes of our well known Upright Drills. The smaller sizes are unequalled for light, accurate work, and the larger sizes are built to stand the strains of heavy work.

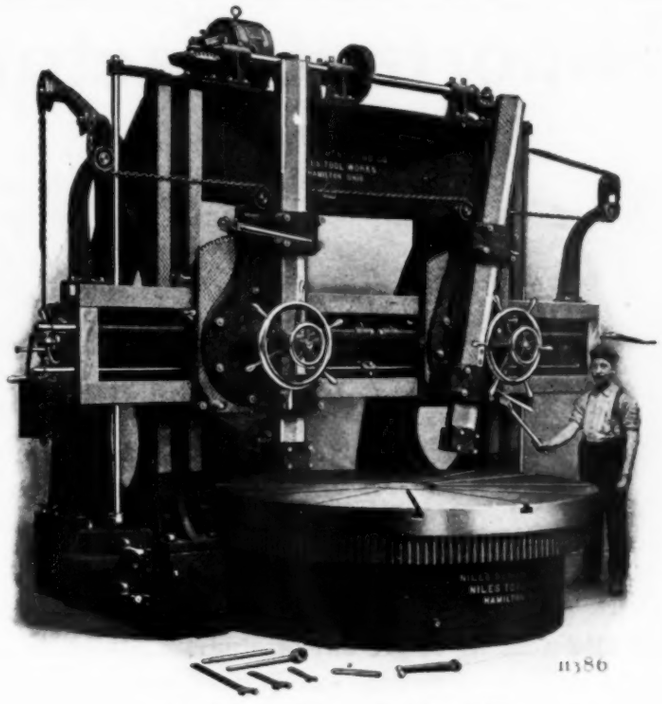
We also make Gang Drills, Horizontal Drilling and Tapping Machines, etc.

ASK FOR CATALOG A

THE ROCKFORD DRILLING MACHINE Co ROCKFORD ILL. U.S.A.



English Address, 149 Queen Victoria St., London, E. C. H. W. Petrie, Ltd., Toronto, Agent for Montreal and Vancouver. Henri Benedictus, Agent for Belgium. Edgar Bloxham, Agent for France and Italy. Thomas McPherson & Son, Melbourne, New York Export and Import Co., Agents for India, Japan, China and the Philippine Islands. Alfred H. Schutte, Agent for Western Germany, Switzerland, Spain and Portugal.



10-ft. Niles Boring and Turning Mill.

A Flat Bearing

on a boring mill table is superior to the usual "V" track, in that the V has a tendency to wedge itself under heavy cuts and to lift the table under side cuts.

The Niles Boring Mill has a wide flat annular bearing. It also has a spindle of large diameter which runs in a bearing having adjustment for wear by means of a taper sleeve. The table has also a lower step-bearing running in oil which enables it to be raised off its annular bearing when running at high speed.

Niles Boring Mills are readily convertible from belt to motor drive. They have many other features equally as effective.

Send for Catalog "Boring Mills."

Elasticity Is Essential

in Drop Hammers. All Bement Drop Hammers are equipped with strong, steel spiral springs between anvil and cylinder frames.

Frames are pocketed in the anvil to prevent spreading, and also lipped over the anvil to prevent lateral movement. Frames are tied together at top, both back and front, by heavy bolts, which prevent shocks being transmitted to cylinder casting.

Each hammer is thoroughly tested with steam before leaving our works.

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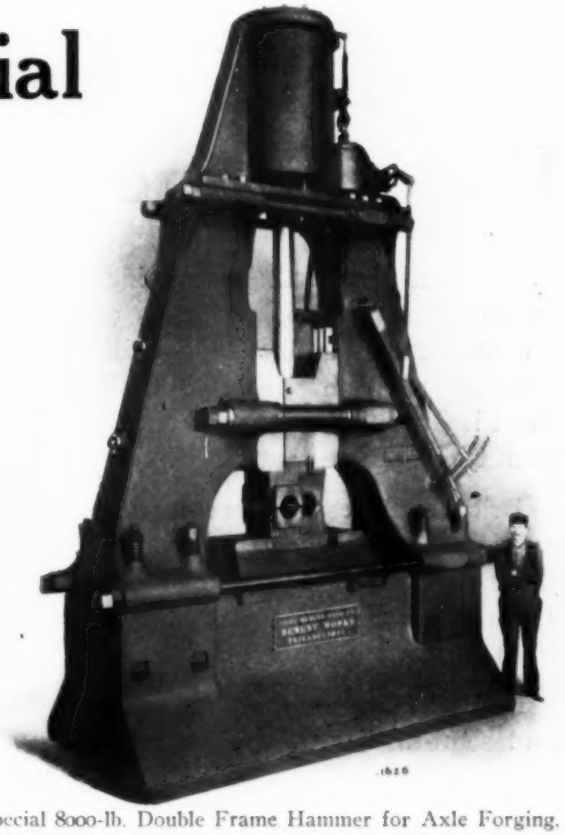

Special 8000-lb. Double Frame Hammer for Axle Forging.

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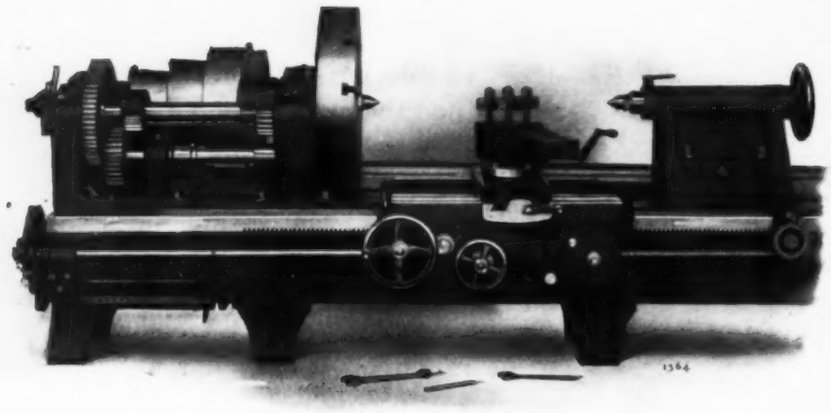
Gearing is an Important Factor



36-in. Pond Engine Lathe—Cone has three wide steps.

in heavy turning. To get maximum output per horse-power gears must have proper pitches and proper width of faces.

The **Pond Engine Lathe** was designed for heaviest turning. All its parts are in keeping with the massive and rigid bed. All gears are steel and have large pitches and wide faces.

The whole construction is very simple and easily taken down. Practically nothing to get out of order. Attachments are numerous, facilitating rapid production. All sizes up to 125 in. swing.

State requirements and receive full particulars and photos by return mail.

Spindles Under Control

at all times for starting, stopping, reversing or tapping by means of a convenient handle on the drill-head of the **Niles Radial Drill.** Feed is automatically thrown out each time spindle is stopped.

Drill head is especially compact, and has levers and hand wheels placed conveniently for operator. It can be swiveled to any angle from vertical to horizontal.

Built in two styles, universal and semi-universal. Four sizes.

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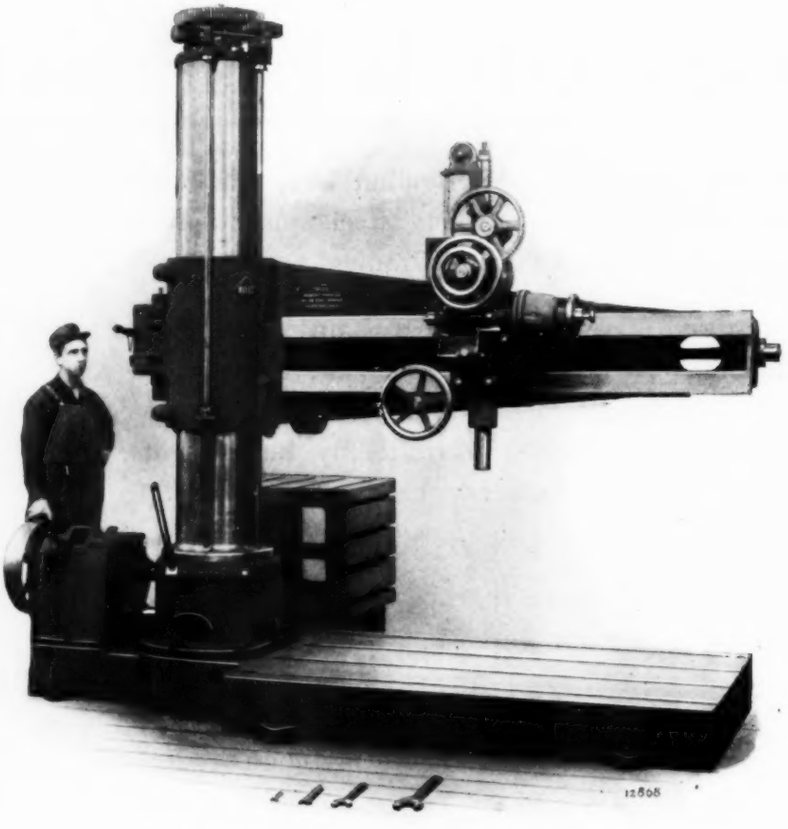

6-ft. Niles Semi-Universal Radial Drill.

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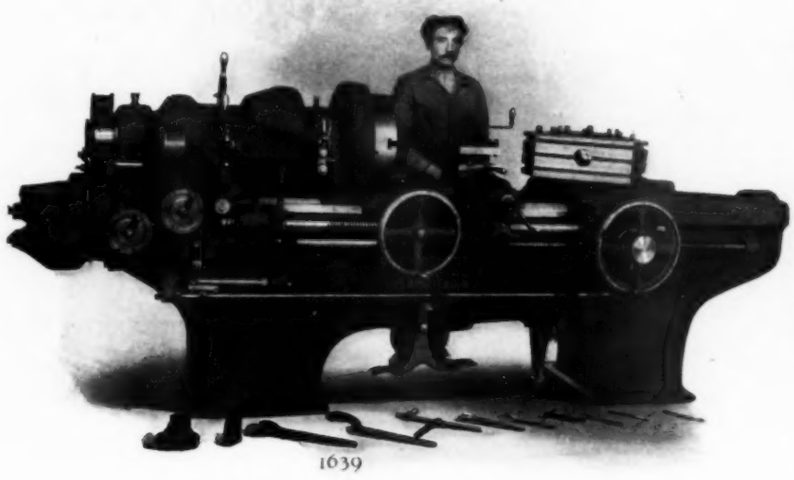
A Turret to be Efficient



21-in. Pond Rigid Turret Lathe.

must respond quickly and readily and at the same time be of the most rigid construction, and capable of withstanding the severest work without altering the alignment.

The **Turret** on the **Pond Rigid Turret** Lathe is built to fulfill these conditions. Its triangular shape affords three exceptionally wide faces which permit the heaviest facing, multiple turning and forming tools to be rigidly supported. The three narrow faces are used for boring bars and reamers. The turret rotates, and locks and clamps automatically with any desired tool in position. It has rapid power traverse in either direction.

Send for complete Catalog "Pond Rigid Turret Lathe."

The Acme of Simplicity

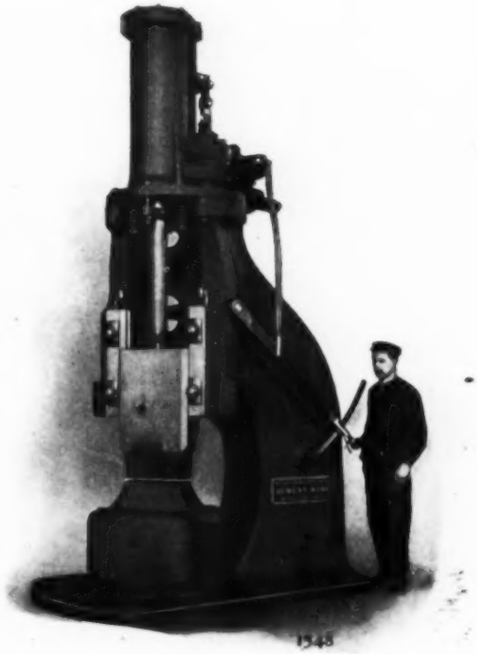
A Bement Hammer

for steam or compressed air.

Simple and substantial valve gear—no connection with ram, thus escaping all concussion.

Throttle valve of the rotary type. Main valve of the piston type. With these two valves any desired variation in length, position, rapidity and force of blow can be obtained.

Cylinder so designed that water drains to lower steam-port or exhaust pipe, where it may be withdrawn.



1100-lb. Bement Single Frame Hammer.

Send for the Catalog "Steam Hammers"—full of valuable information.

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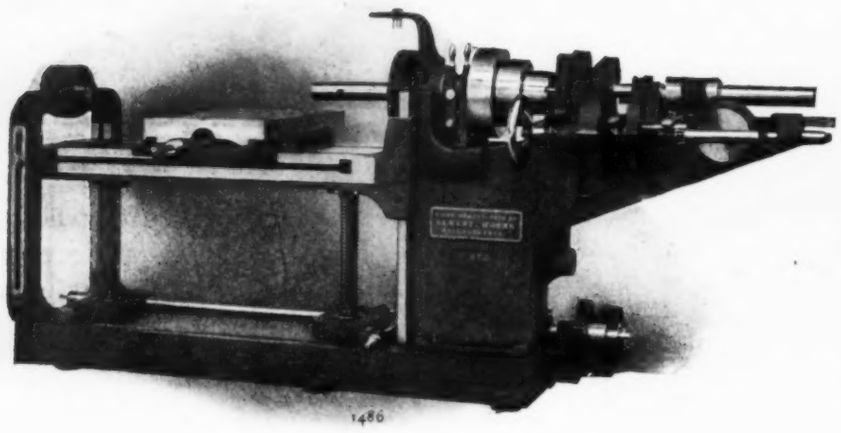


60-in. (3⅛-in. spindle) Horizontal Boring and Drilling Machine.

Automatic Reversible

Boring and Drilling Feeds

to facilitate rapid production on the **Bement Horizontal Boring and Drilling Machine.**

Main table is supported on two large screws and is raised and lowered by power.

The cross tables may also be furnished with power cross- and longitudinal-feeds for milling. Extra round table, with or without power rotary motion, may be fitted to cross-table.

Spindle bearings are of liberal dimensions, and table has long bearing on column.

Send for Catalog "Horizontal Boring and Drilling Machines."

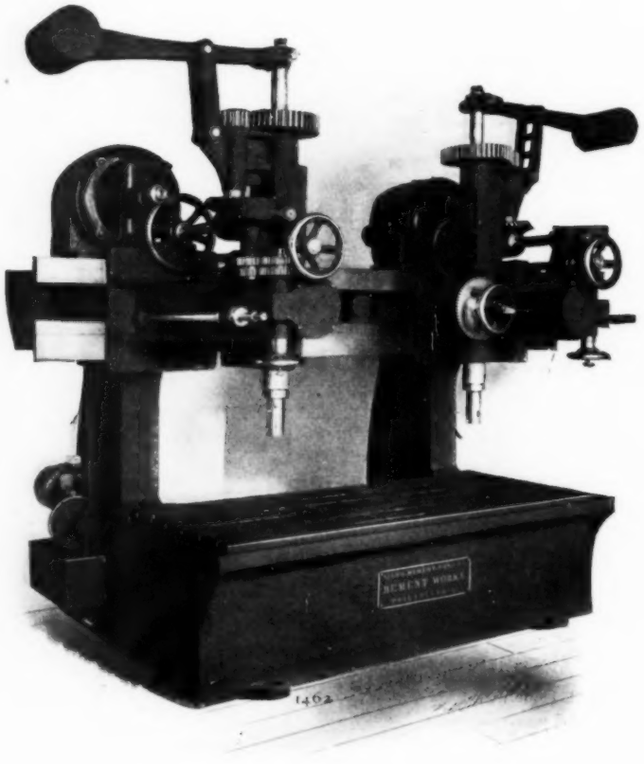
Independent Motor Drive For Each Spindle

permitting rapid drilling and rapid handling. Spindles are 3 in. in diameter. Minimum distance between spindles 15 in., maximum, 76 in. Individual cross traverse for each spindle 13 in.

Built also in larger sizes and with one or more spindles.

These machines are indispensable for economically boring locomotive connecting rods and similar work.

Further particulars and photos sent upon request.



2-Spindle Drill for Locomotive Work.

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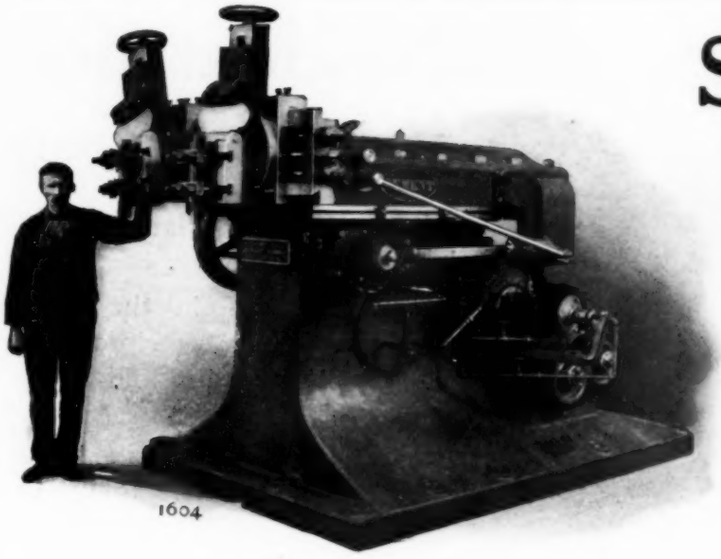

Column Shaping Machine.

Self Contained And Portable

The Bement Column Shaper.

This is a very heavy shaping machine primarily designed for shaping out pods on ends of rolling mill rolls, but it can be applied equally as efficiently on other heavy shaping work.

The machine is intended to be placed on floor plate with work mounted on same. Cutter bar has two swivel planer heads on cross rail with automatic cross-, vertical-, and angular-feed. Power is by 20 H. P. motor, directly attached.

Send for illustrated Circulars.

No Cast Iron

The crank shafts of the Bement Slotting Machines are steel-forgings of large diameter and great torsional strength, permitting heavy cuts without undue strain.

Feed is positive in its action and variable from fine to coarse cuts. It is actuated by cam on crankshaft and is designed to act in a small portion of stroke.

All wearing surfaces are liberally designed.

Great power is obtained through large cones for wide belts and an exceptionally large main driving gear.

Nine sizes: 6 to 68 in. stroke.

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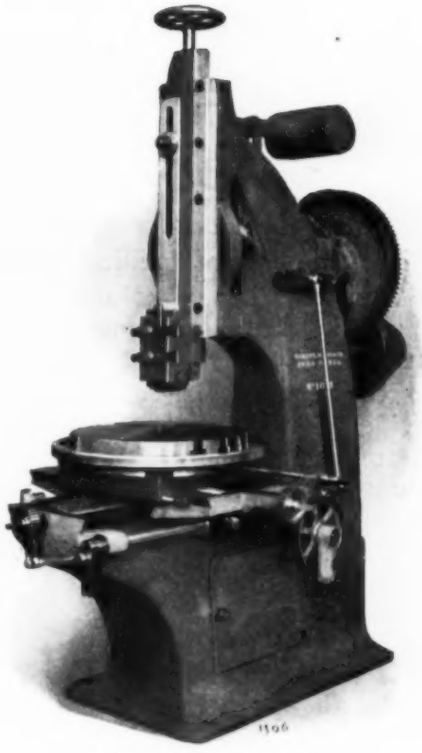

10-in. Slotting Machine.

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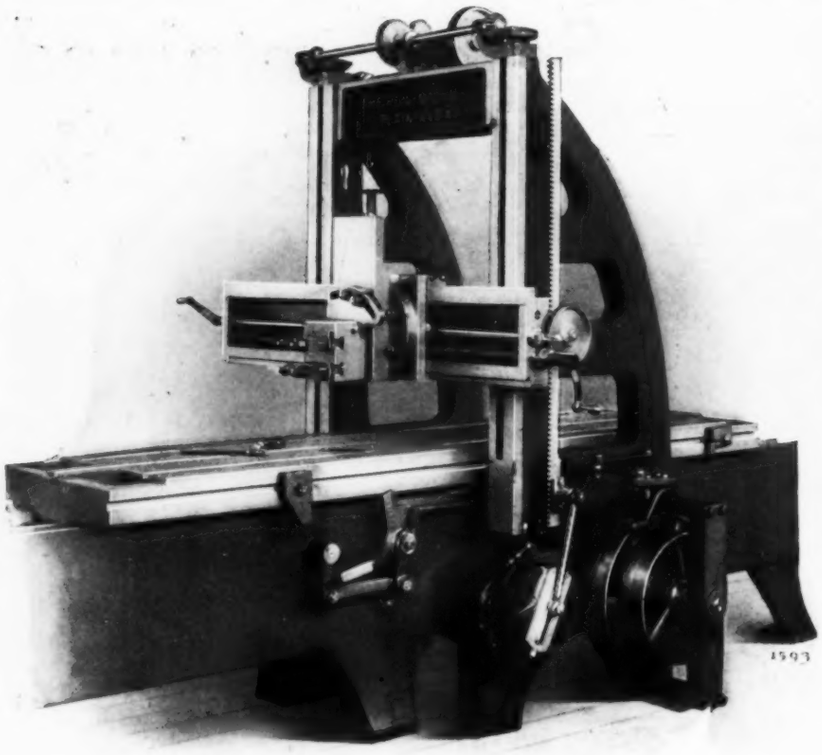


32-in. Pond Planer.

No Hesitation in the Action

of Pond Planers

They maintain the same, never varying, reciprocating motion under light and heavy cuts.

There is no excessive vibration—no noisy gears taking up lost motion due to back-lash on the return stroke.

Pond Planers are built right. They are rigid and powerful and remain in alignment.

Built in sizes from 17 in. to 14 ft. between housings.

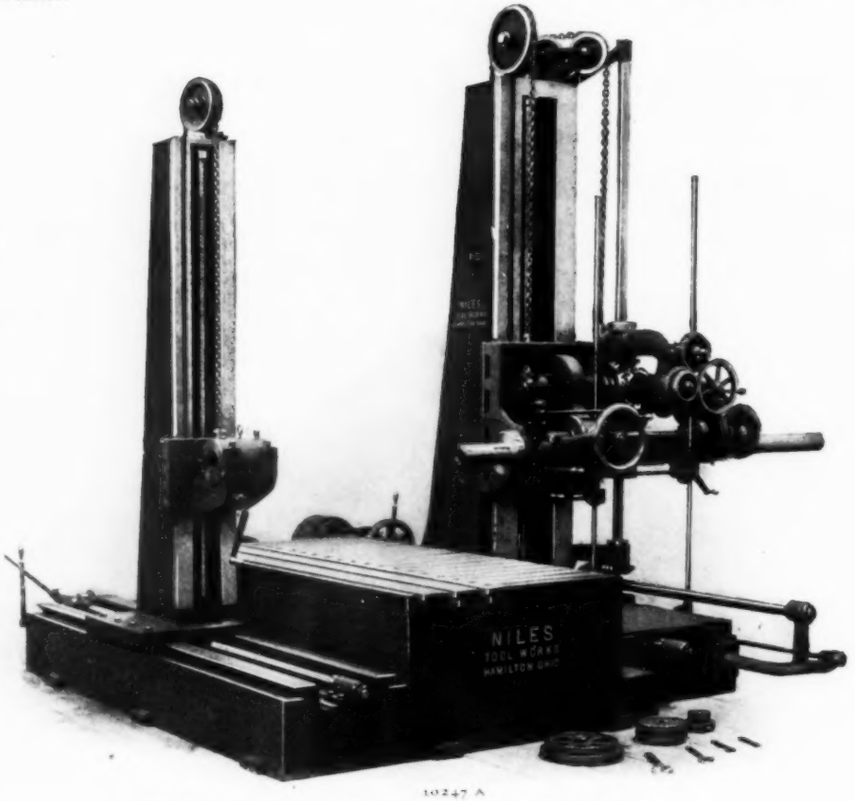
Send for Catalog "Pond Planers."

Graduated Scales

on both horizontal and vertical slides to facilitate the rapid setting of column and saddle to drawing dimensions.

Rapid power traverse is provided for saddle, column and out-board column. Motor drive, $4\frac{1}{2}$" spindle, long column traverse and other features on this **Niles Horizontal Boring, Drilling and Milling Machine.** Exceptionally valuable where long range of column movements is necessary for such work as printing press frames, etc.

Write for Catalog "Horizontal Boring, Drilling and Milling Machines."



Horizontal Boring, Drilling and Milling Machine.

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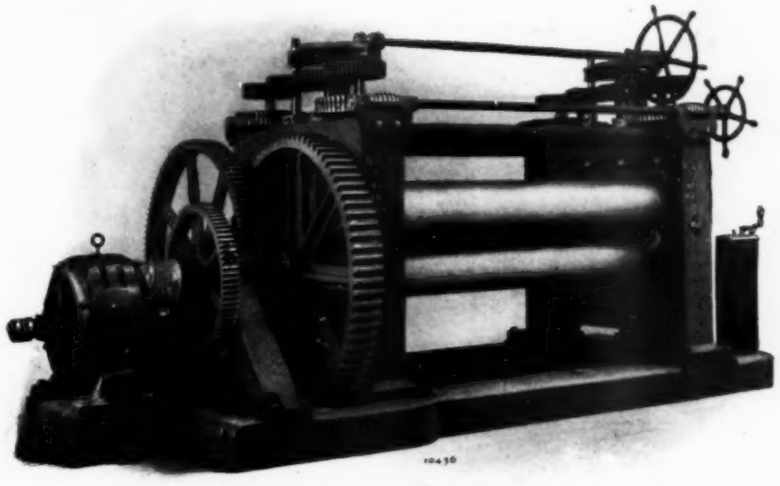
Unavoidable Rough Usage

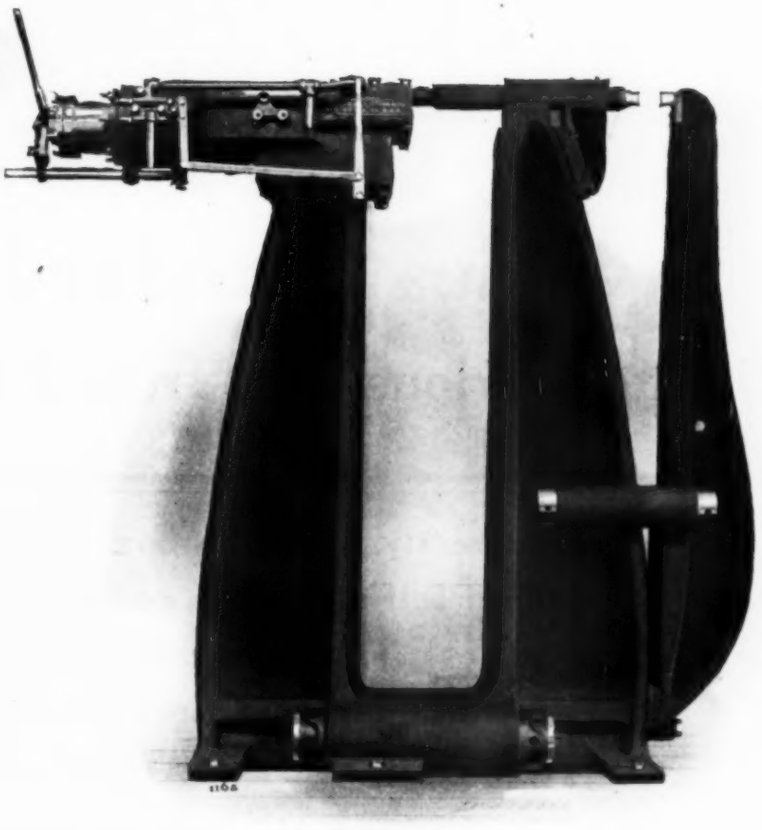


Straightening Rolls, Motor Driven.

in Ship Yards, Boiler Shops, Bridge Shops, etc., subjects machinery to much abuse.

Niles-Bement-Pond Plate Working Machinery is of massive and rigid construction—built for severest continuous service.

Straightening Rolls and Hydraulic Riveters



100-ton, 3-pressure, Hydraulic Riveter, with Auxiliary Stake.

are only two of the numerous N-B-P plate working machines built.

Some others are Bending Rolls, Plate Planers, Hydraulic Presses, Punching and Shearing Presses, Flanging Clamps, Flanging Presses, Rail Benders, Hydraulic Accumulators, etc.

Send requirements and receive data, full particulars, and photos by return mail.

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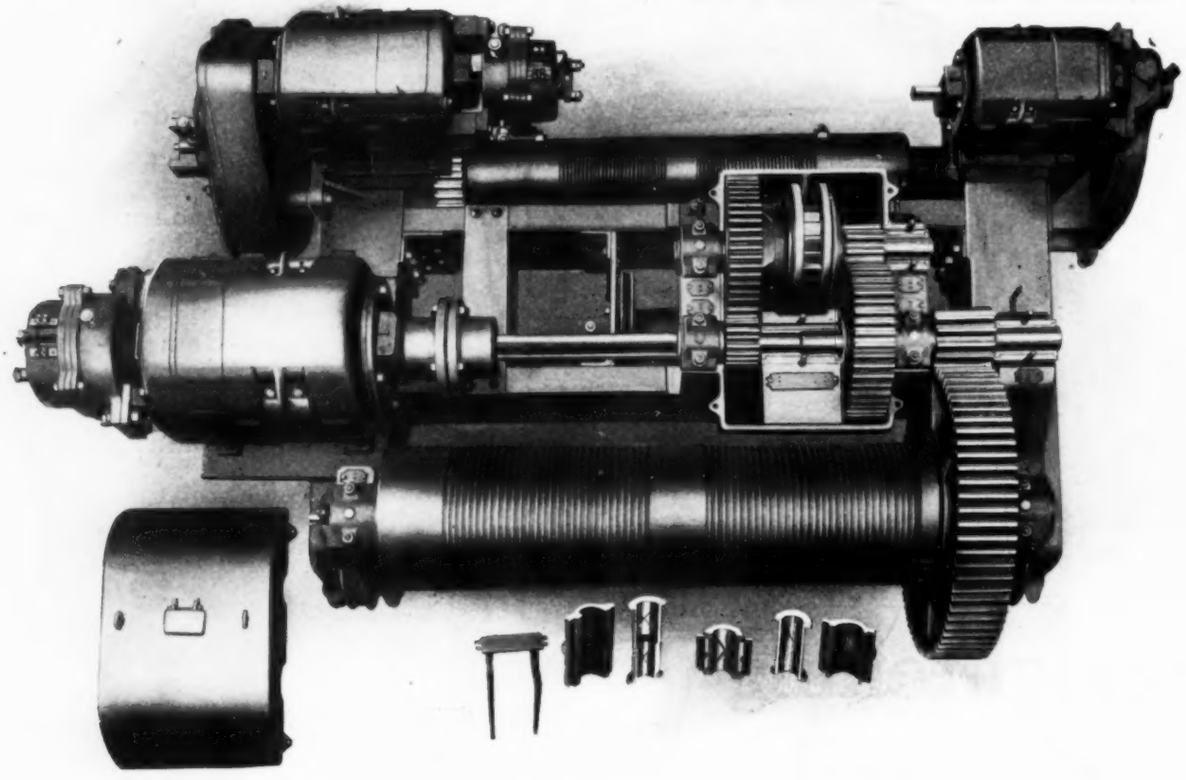

Niles Standard Trolley

Built in various sizes from 2 to 200 tons capacity

Motors directly bolted to box side frames. Trolley drive mechanism self contained, complete in gear case. No overhung gears. Thorough lubrication and protection of gears against dust and mechanical injury. No cast gears. All gears cut accurately. Self-oiling bronze bearings.

Send for Catalog "Niles Cranes."

NILES-BEMENT-POND COMPANY

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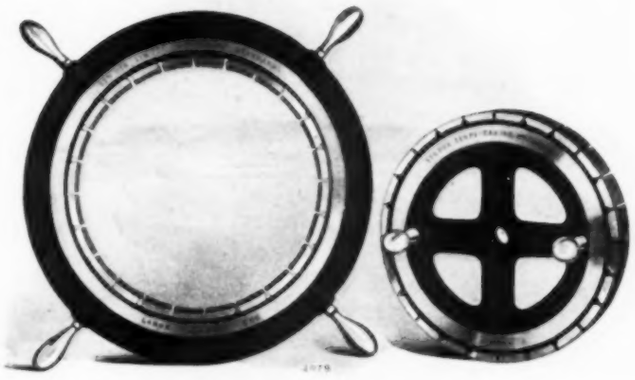
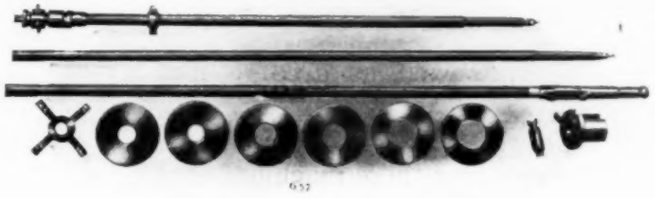
Standard Gauges For All Purposes

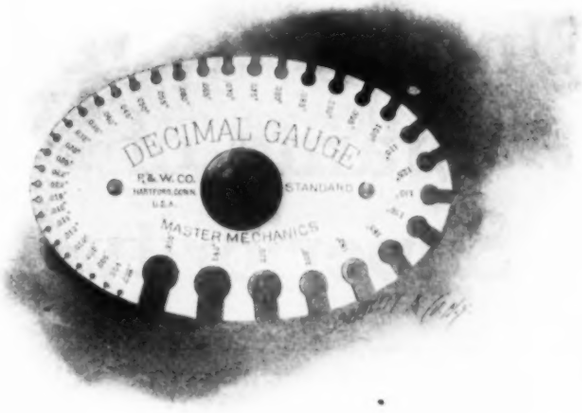
Standard Oil Well Casing Gauges (Patented) have the same style of thread and similar construction as the Brigg's Standard Pipe Gauges, the difference being in the taper, which is $\frac{3}{8}$ in. per foot.





P. & W. Star Gauges are used for testing the accuracy of internal diameters, especially where the length of bore is so great that it practically prohibits using any other form of gauge.

Decimal Gauges adopted as standard by the American Railway Master Mechanics' Association of American Steel Manufacturers. Manufactured under license of the American Society of Mechanical Engineers by P. & W.



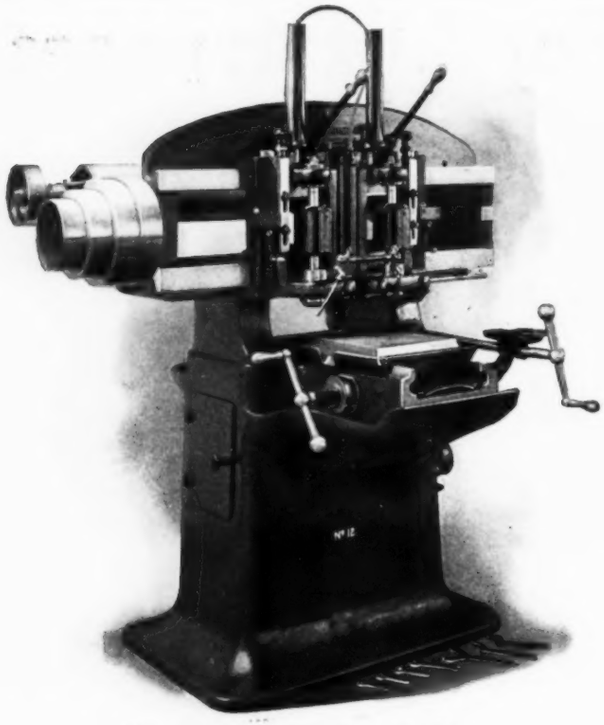
P. & W. Dial Test Indicator is invaluable to use in connection with a surface or spindle grinder. It is very sensitive, has a very delicate adjustment, and is made of bronze, hence will not rust or become magnetized.

The Catalog "Gauges and Standards" has a number of useful tables—sent on request.

PRATT & WHITNEY COMPANY

HARTFORD, CONN., U. S. A.

(See offices on page 3)



No. 12 P. & W. Profiling Machine.

Government Stamp of Approval

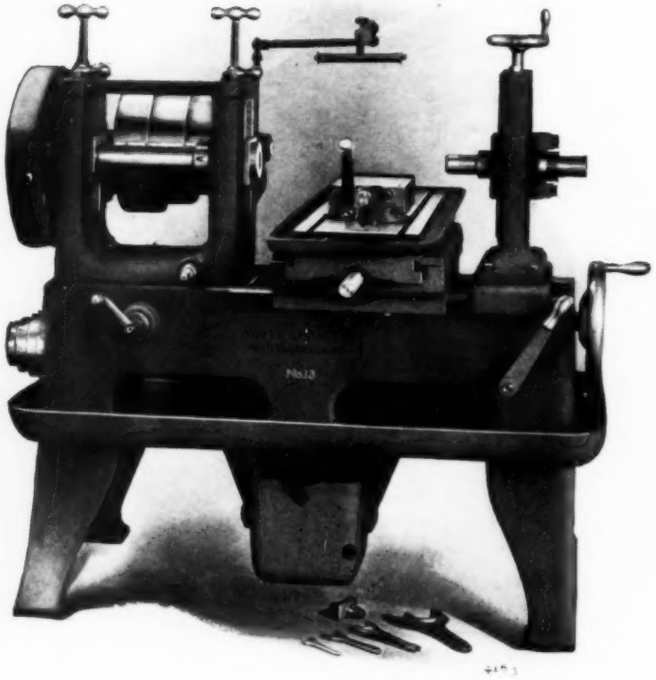
The adoption of the P. & W. Profiling Machine and the P. & W. Lincoln Milling Machine by the U. S. Government, as well as a large number of foreign governments, for arsenal work, gives these machines the

Unquestioned Stamp of Superiority

for the manufacture of small arms.

They are equally as efficient, both in point of economy and rapid production, for the manufacture of sewing machines, automatic vending machines, typewriters, motor cycles, automobiles, etc., where extreme accuracy and exact duplication is pre-eminent.

Built in various styles and sizes.



No. 13 Lincoln Milling Machine.

Send for Catalog "Profilers and Millers."

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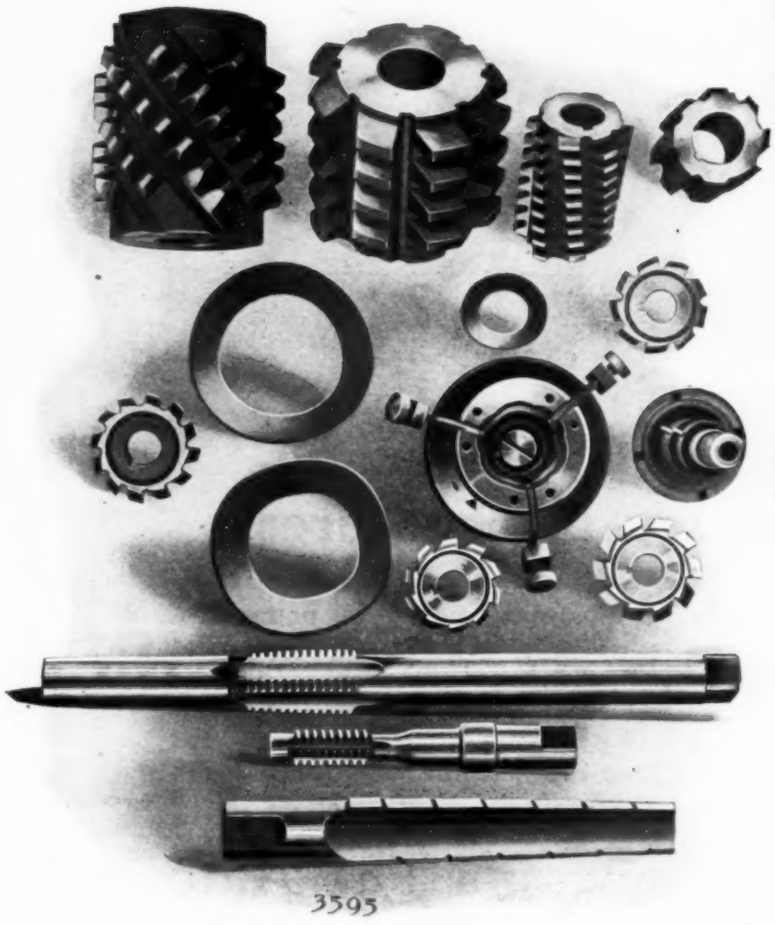


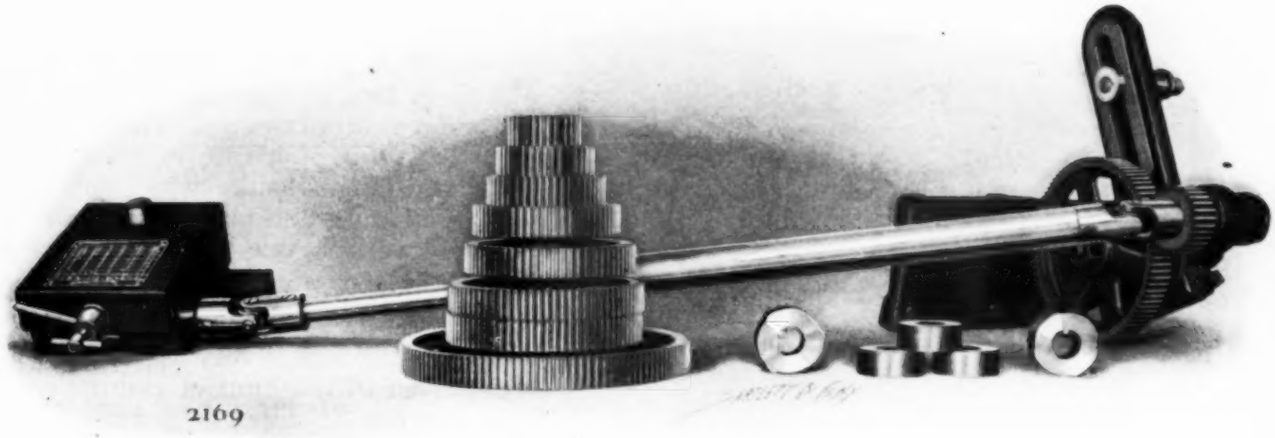
Specimens of Relieved Work.

Not A Separate And Expensive Machine

but an attachment that is as readily applied to a P. & W. 14 or 16 in. Engine Lathe as a face plate—the

P. & W. Relieving Attachment.

No science or great mechanical skill required to use it—as simple as thread cutting. Indispensable in the tool room.



Send for Catalog "Lathes"—fully described in it.

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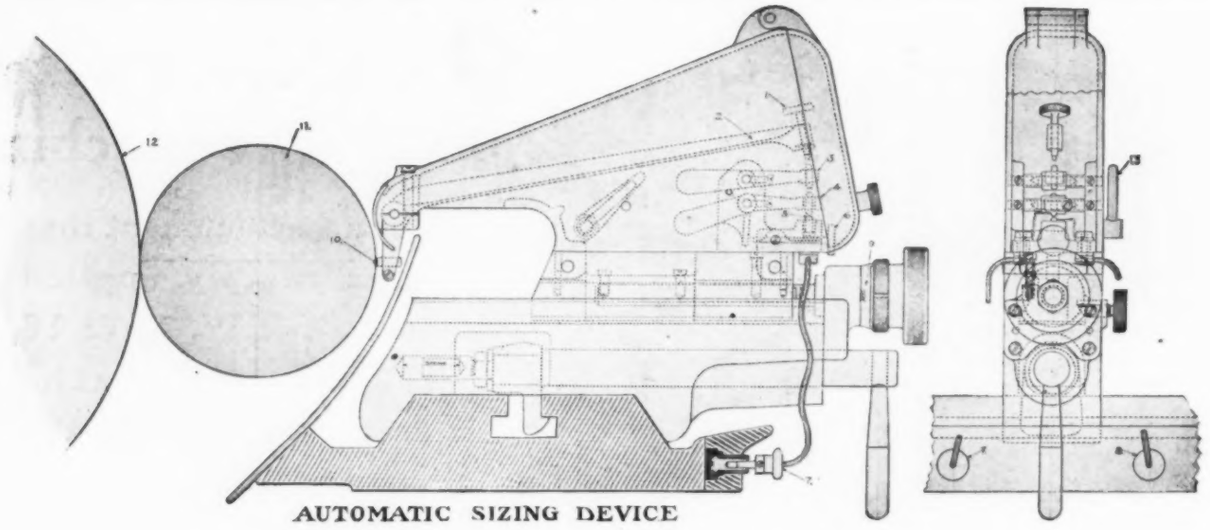


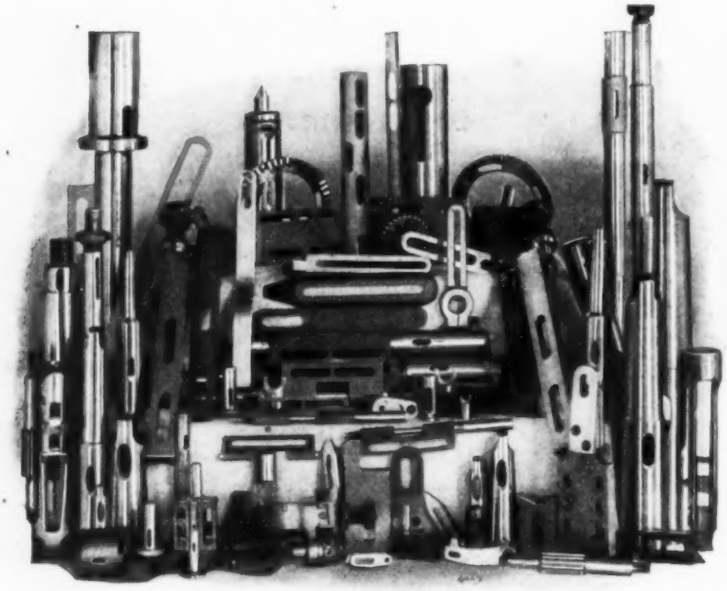
AUTOMATIC SIZING DEVICE

Leading Ideas And Features

in attachments or machines that actually reduce operating expenses, increase output, facilitate rapid handling, and promote ease of handling, **are characteristic of the name P. & W.**

The Automatic Sizing Device on the P. & W. Auto Sizing Grinder assists in all the foregoing and more. It prevents oversize, undersize, mistakes in duplicate lots, and permits a man to operate several machines at one time.

Send for illustrated Circulars "The Automatic Sizing Grinder."



Specimens of work done on a P. & W. Spline Milling Machine.

It's The Automatic Features That Save Time

The P. & W. Spline Milling Machine employs two inexpensive end mills of peculiar fish tail design. These cutters revolve at a high rate of speed and will mill tang slots, keyways, slots with enclosed ends, and numerous forms of similar work, in one-tenth of the time that these operations can be done by hand.

The machine is very rigid and can be driven to the limit of endurance of the cutters.

Samples sent for specimen work and cost estimates given prompt attention.

Send for Catalog "The Spline Miller."

PRATT & WHITNEY COMPANY

HARTFORD, CONN., U. S. A.

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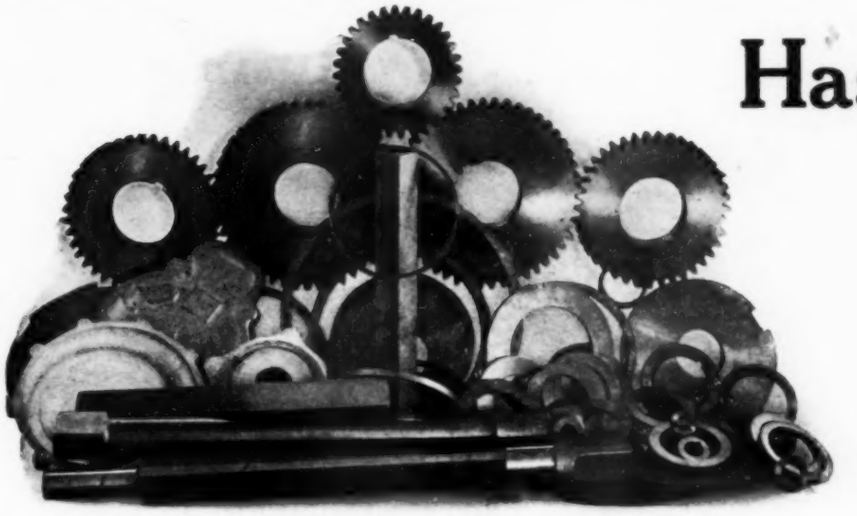


A few specimens of Automobile Parts Grinding.

Has No Equal

The P. & W. Vertical Surface Grinder has absolutely no equal. It has made possible an increased output from 100 to 1000 per cent. over any previous method of grinding. It will grind any material, any shape, and with extreme accuracy.

Write for further data and specifications.

Milling Is Superior To Planing

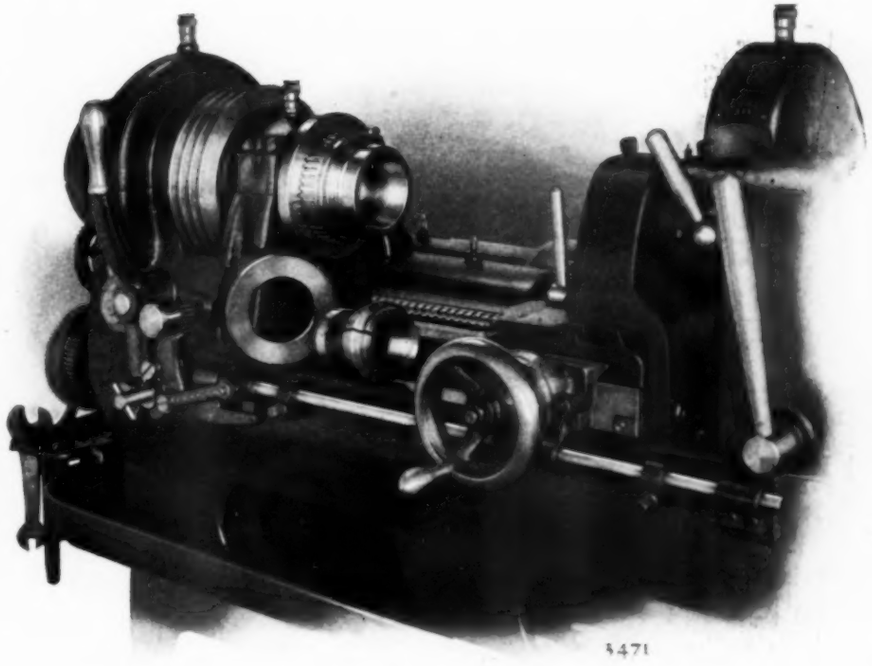
not only in quality of work, but also in time and convenience.

To cut a thread on an engine lathe is similar to a planing or shaping operation with all its incidental disadvantages.

A thread to be precise and have a superior finish, and to be completed in an exceptionally short time ensuring exact duplication in any number, **should be milled.**

The P. & W. Thread Milling Machine is the only Thread Miller.

One man can operate six machines.



5471

Thread Milling Machine Spindle Nose, Carriage and Follow Rest.

Send for Catalog "Thread Millers."

PRATT & WHITNEY COMPANY

HARTFORD, CONN., U. S. A.

(*See offices on pages* 3)

Pratt & Whitney Co.,

Hartford, Conn., U. S. A.

Precision Die Stock Sets

in following standards:

U. S. S.,

Whitworth,

V form,

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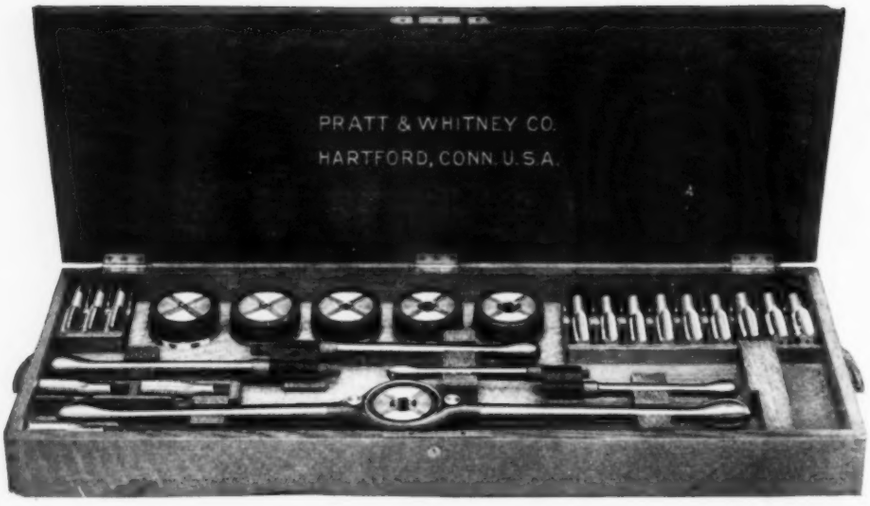
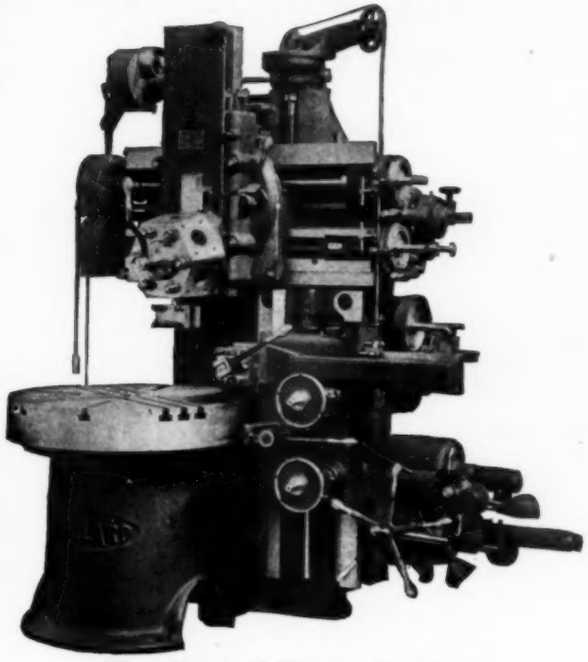
British Association

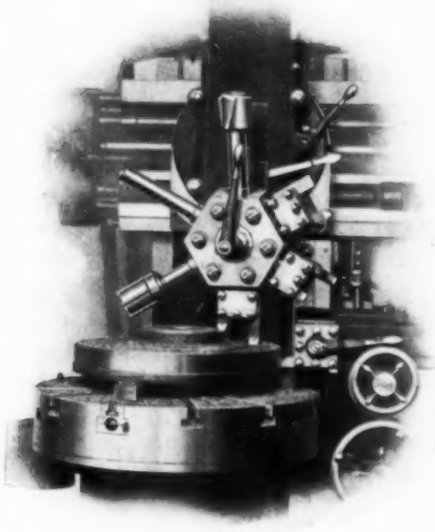


Everything in P. & W. small tools described in Catalog "Small Tools" — mailed upon request.

(See offices on page 3)



The Vertical Turret Lathe.



Showing 3 Tools Cutting At Once.

BULLARD

Vertical Turret Lathe

"To Cut Costs, Cut Time Between Cuts"

The application of that line to our lathe is clearly shown in the illustration. By operating two or three cutting tools at once and having the other tools needed for a whole series of operations in instant readiness, the Bullard Vertical Turret Lathe saves valuable time, and does more work more accurately than any other tool in its class.

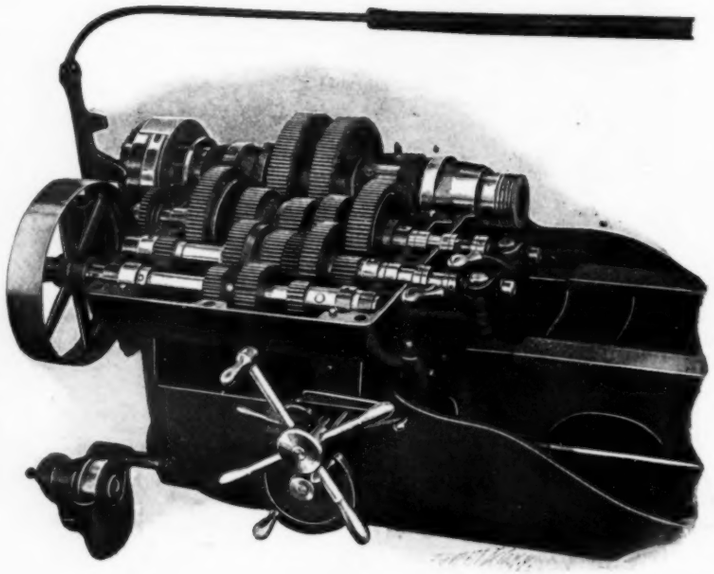
Send for Catalog 30.

The Bullard Machine Tool Co. BRIDGEPORT, CONN., U.S.A.

AGENTS—Marshall & Huschart Machinery Co., Chicago, Ill. The Motch & Merryweather Mchry. Co., Cleveland, O. Chas. G. Smith Co., Pittsburg, Pa. C. H. Wood Co., Syracuse, N. Y. Pacific Tool & Supply Co., 556 Howard St., San Francisco, Cal. Williams & Wilson, Montreal, P. Q. A. R. Williams Mchry. Co., Toronto, Ont. Chas. Churchill & Co., Ltd., London, E. C., England. Fenwick, Freres & Co., Paris, France. Heinrich Dreyer, Berlin, Germany. Landre & Glinderman, Amsterdam, Holland.

The "Flat Turret's" Self-Contained Speed Variator Is A Valuable Feature

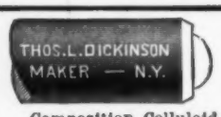
The sliding headstock is securely gibbed to guideways running across the machine thus providing a cross feed for each tool. The single drive receives power at a constant speed and in one direction; when driven by electric motor no controller is necessary, only a starting box; cross sliding head has ten stops carried in a revolving holder which is turned at will by operator. Lower half of all running parts is submerged in oil to insure perfect lubrication.



For more "Flat Turret" details see pages 12 and 13.

Jones & Lamson Machine Company,

Springfield, Vermont, U. S. A., and 97 Queen Victoria Street, London, E. C.



DIAMOND TOOLS

Special shaped carbon, black diamond, pointed tools for turning Hard Rubber, Fibre, Brass, Bronze Composition, Celluloid, Paper, Cotton and Corn Husk rolls; for turning and drilling Battery Carbons or any material of a hard, tough, gritty nature. Hold their sharp cutting edges for months, they can be sharpened.

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Twelve Medals Awarded at International Expositions

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G. & H. BARNETT CO., Phila., Pa.

Our "D" Standard Grinder

is an ideal machine for general use in Foundries and Stovemakers' Works. The spindle runs in long babbitted bearings with two oil rings in each. This grinder takes emery wheels to 20″ x 4″ x 1½″.

Five other sizes of Standard Grinders are shown in our catalog. Let us send it to you.

DIAMOND MACHINE COMPANY,

PROVIDENCE, R. I., U. S. A.

of the carriage moves the torch away from or toward the machine, and as the oxygen nozzle should always follow the pre-heating nozzle, the torch may be turned around by the small lever shown. The torch, as are all the torches, is provided with a valve for shutting off the gas. At the bottom of the machine is located a straight edge on which the nozzle slides. By means of an additional attachment that is not shown, the torch can be made to cut in a vertical direction.

FIG. 8. APPLIANCE FOR CUTTING CIRCLES WITH BRACE

FIG. 9. TRAMMEL POINT ON BEAM FOR CUTTING LARGE CIRCLES

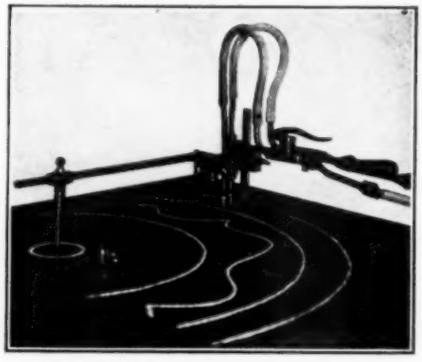


FIG. 11. ANOTHER MACHINE CUTTING REGULAR AND IRREGULAR CURVES

In Fig. 7 are shown some samples of the work done with the above machine. The slabs themselves were first cut off with the oxhydric torch, and afterward the irregular cuts were made in the slabs. The narrowness of the cut, the square corners that it is possible to turn, and the fact that the metal is not burned on the sides of the cut are plainly seen.

The closeness with which the metal can be cut to a line is best illustrated by the small slab in the upper right-hand corner. In the center of the slab it will be noticed that there has been left a thin strip of metal. This is but ⅛ of an inch thick, while the cut is 1¼ inches deep, and is practically no wider at the bottom than at the top.

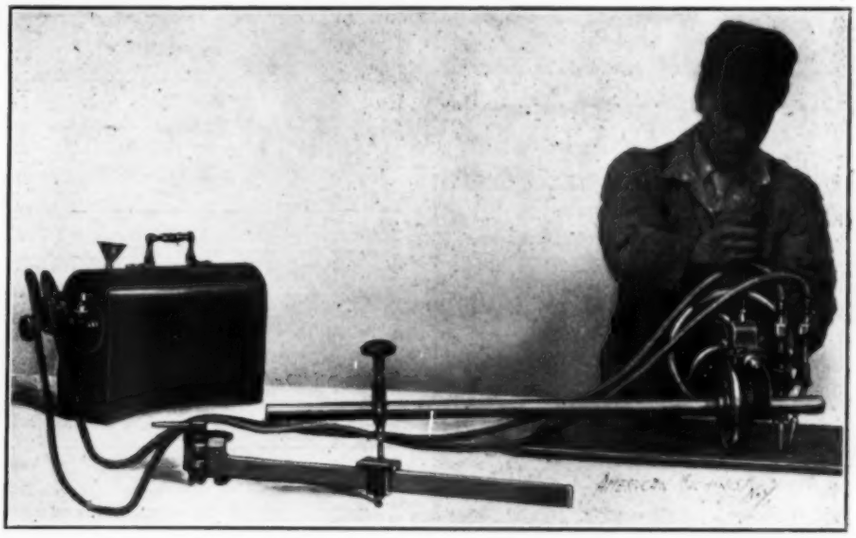


FIG. 10. MACHINE FOR REGULAR OR IRREGULAR CIRCULAR CUTTING

Cutting Regular and Irregular Curves

By Fig. 8 is shown an appliance which can be used in an ordinary brace for cutting circles from 2 to 12 inches in diameter and in Fig. 9 is shown the apparatus that can be attached to a beam located in a trammel point for cutting large circles. It will be noticed that the torch is fastened by thumb screws to two U-shaped rods that are mounted on wheels. Either of these rods, or both together, can be raised or lowered so as to accommodate the torch to any inequalities in the surface of the metal, or to locate it the proper hight above the metal for successful cutting.

A machine for regular and irregular circular cutting is shown in Fig. 10. In this the hand wheel is used to turn the wheel, located on the trammel beam, by worm gearing, and thus give the torch a steady travel around the centering trammel point.

A slot is cut in the end of the beam so the operator can move the torch back and forth while he is moving the whole machine in a circle. The torch can also be revolved on 45 degrees of a circle so the heating nozzle can be kept in front of the oxygen nozzle.

By Fig. 11 is shown another machine for cutting regular or irregular curves together with some of the curves which have been cut. There is a small wheel located on a bar near the nozzle of the torch and this can be raised or lowered to locate the torch at its proper distance above the plate. The torch can be swung around so as to always keep the heating nozzle ahead of the oxygen nozzle. The apparatus is provided with an extra guide wheel, and an adjustable point which can be used where the guide wheel would interfere with the cut.

Cutting Steel Tubes

One of the most useful applications of this process is in the cutting of steel tubes or pipe. A special attachment has been made for this purpose, which is shown in Fig. 12. It is made in several sizes to accommodate the different sizes of pipe.

The pipe is inserted in the center of a ring and is clamped there by three set screws. The torch is then revolved around the pipe and cuts it with a good clean cut and hardly any waste of metal. A small wheel, that runs around the pipe back of the nozzles, locates their position and adjustment can be obtained by means of a spring inside of the apparatus. This apparatus is especially valuable in plants where power is not available. The cost of cutting pipe by this process can be obtained from Table 3, which gives the amount of gas consumed when cutting

Convention of Pennsylvania Engineers

The first State convention of Pennsylvania Engineers was held at the capitol, in Harrisburg, on June 9, 10 and 11. So far as we know this is the first State engineering convention ever held in the United States, and in that respect it marks a forward step for the profession of engineering.

The activities of the convention readily group themselves under four heads; business, or the forming of a permanent organization and a discussion of an engineering code; professional papers by experts; social features, including a smoker and banquet, and a manufacturers' exhibit held in the largest hall in the city.

The call for the convention was sent out to some 5000 engineers by the convention section of the Engineers' Society of Pennsylvania, with the purpose of uniting them in a movement to formulate a code and later draft bills to be presented to the State legislature two years hence. At the session of the legislature just closed such a bill was introduced by interests unknown. It was deemed so pernicious, however, that the engineering societies of the State united to kill it in committee. This was done, but a pledge was given to the legislature that at the next session a bill, or bills, would be introduced, which would be indorsed by the engineers of the State.

At the business session on Wednesday afternoon Professor Jackson, of the Pennsylvania State College, was elected chairman, and proceeded to formally organize the convention and select certain committees.

The address of the afternoon was given by F. Herbert Snow on "Outlines of a Code with Legislative Backing." By vote, discussion was deferred until Friday, but hearty support of the idea of the code and of suitable State legislation was expressed. The secretary of the Society of Engineers of Western Pennsylvania, and a delegate from the Engineers' Club, of Philadelphia, stated the active interest of their societies in the movement and pledged support.

The illustrated lecture of the afternoon was delivered by Prof. J. T. Rothrock on forestry with particular reference to Pennsylvania. Its drift was a stirring appeal to the engineers to stem the tide of forest waste, and bequeath to their children forest-covered hills and power-producing streams, instead of barren and eroded lands and gullies ultimately devoid of water and filled with destructive freshets.

Over 60 firms showed their product in the manufacturers' exhibition. It is impossible to mention them all here; those selected for reference have more direct bearing on machine building, although many other interesting and instructive lines of manufactures were shown.

The Harrisburg Foundry and Machine Works had a governor wheel and details of Fleming-Harrisburg engines; they extended to each engineer a cordial printed invitation to visit their plant. The Central Iron and Steel Company's booth contained sample bends of plates and bars, specimens of flanging and several steel railroad ties. A profusion of nuts, bolts, lag screws, turnbuckles and associated articles was shown by the American Iron and Steel Company.

A booth always surrounded by a crowd was the one at which lifting magnets were demonstrated by the Electric Controller and Manufacturing Company. Another working exhibit was a blueprinting machine, washer and drier, built by the Williams, Brown & Earl Company. A booth at which everyone who wished received something, was that of the McGraw Publishing Company, where specimen copies of their technical periodicals were shown.

Wednesday Evening Smoker

The first of the purely social features of the convention was the smoker, held in the auditorium of the Board of Trade building. Some 500 engineers enjoyed the cigars, lunch, songs, stories, and a few acts from the local theaters. Everything was well planned and well executed by the committees and well received by the guests.

Thursday Sessions

After a brief business session, held in the Senate chamber of the Capitol building, which received preliminary committee reports, three professional papers were presented: "The Disposal of Sewage," by F. Herbert Snow; "Gas Engines," by E. T. Adams; "Preservative Treatment in Relation to Cross-tie Supply," by E. A. Sterling.

At the afternoon session five papers were read by their authors, the first three illustrated by lantern slides: "Relation of Electric Furnaces to Siderurgy," by P. McNiven Binnis; "A Few Notes on Telephone Construction," by Nathan Hayward; "Electrification of Railroads," by Fredcrick Darlington; "Water Purification," by George A. Johnson; "Disposal of Manufactural Waste Separately and in Conjunction with Normal Sewage," by Frank A. Barbour.

In the evening a large and enthusiastic audience listened to and saw a pictorial story of the engineering work that has been done and is in progress on the Isthmian canal. The speaker was Lieut.-Col. H. P. Hodges, Corps of Engineers, U. S. A., assistant engineer Isthmian Canal Commission.

Colonel Hodges briefly reviewed the history of the canal, referred to the recent attacks upon the lock type, took up these attacks point by point and showed the fundamental engineering reasons that lie at the foundation of the decisions that had been made in regard to type. This part of the lecture was most convincing, and we fail to see how any unbiased engineer can favor the sea-level project after such a clear exposition of the tremendous difficulties and unknown factors that its building would involve, to say nothing of the cost and time required for completion. An attack on the canal type is now an attack on the canal project itself.

Drawings of the locks and gates were shown for the first time to an American audience; indeed, these drawings in detail have been finished but a short time.

The audience was enthusiastic in its reception of the views showing living conditions in the Canal Zone, the work done and machinery employed.

Friday's Business Session

At the final business session a resolution was adopted instructing the executive committee of the convention to invite each of the engineering societies of the State to elect three members of a general committee to work out a draft of the desired engineering code. Very wisely the details of the work of this committee were left to the committee itself, with power to effect its own organization. Upon this committee devolves the most arduous work mapped out by the convention.

A resolution was adopted instructing the chair to appoint a large committee composed, as far as practical, of one member from each county, to aid in ascertaining and crystallizing the engineering sentiment of the State, in discussion of the draft of the code to be drawn up and in intelligently placing before the members of the next legislature the need and character of legislation desired by the engineers of the entire State.

The permanent organization of the convention, as it stands, consists of a chairman, vice-chairman, secretary, executive committee of three, general committee on code and a large committee of county members.

The advisability of sections of the convention embracing members in the same field of activity was expressed in a suitable resolution. A delegate from Pittsburg raised a very pertinent point in stating that he failed to see how the engineering code and legislation would aid the average mechanical engineer, particularly the one employed by corporations.

Suitable resolutions were voted expressing appreciation to the State officials for use of the Capitol building, to the Harrisburg city government, to the many exhibitors and to speakers who contributed professional papers. Five such papers were presented on this, the last day of the convention: "Concrete Bridges," by Daniel B. Luten; "Pavements," by James Owens; "Low-pressure Steam Turbines," by J. G. Callan; "Conservation," by John

Berkinbine and "Dirt Roads," by Alva Agee.

The closing feature of the convention was a banquet in the auditorium of the Board of Trade. This was enlivened by toasts and responses and an illustrated story of some of our great government reclamation work in the West; work whereby thousands of acres of arid land are made fertile and suitable for American homes. Surely this is work of which American engineers can well be proud! The speaker was Arthur P. Davis, Chief Engineer of the U. S. Reclamation Service.

This report should not close without reference to the labors of President Snow, of the Engineers' Society of Pennsylvania, and of Professor Jackson, the chairman of the convention, which were largely instrumental in bringing about the marked success of the meeting, which is, perhaps, best shown by a registration of over 750.

Should Screw Threads Have a 60-degree Angle at Right Angles to the Helix?

By L. E. Dudley

Our shop has decided to adopt the A. S. M. E. standard threads, and is, like many others, passing through the throes of thread-gage evolution.

The gage-making department is my especial protegé, as it is, to my mind, the mainstay of the quality of our product, and I have, therefore, always made it my practice to see that everything was done in the gage room in the most carefully thought-out way, as well as by the most accurate methods and have always found this procedure a paying one.

Thread gages are seemingly, especially to the uninitiated, and by this I mean the majority of educated engineers and mechanics with whom I have come in contact during my career, one of the simpler problems in mechanics. I thought so myself until the fact had been brought home forcibly a number of times that properly fitting interchangeable threads were rarely attained, and then never maintained for any length of time in our shop, and that this condition constituted our weak point and caused a varying quality in our goods.

On investigation our system seemed all right; we bought our thread plugs and templets from the foremost manufacturer in this line, our taps and dies from a prominent firm with high standing, and our screws and nuts from the manufacturer bearing the best reputation for quality, but the system had failed our needs.

On going deeper into the matter we found various causes for the trouble, the two most important of which were slightly varying standards, or different interpretations of the same standards, and inaccurate work resulting in difference of lead and interference of diameters on gages, tools and screws. We decided at any cost to overcome these troubles and installed machinery and tools to make our own gages, templets, taps, dies, screw, nuts, and, in fact, to hold the whole situation in our own hands. This proposition gave us many a bad half hour, and after many trials and tribulations we formulated a system, upon which I may touch at some other time, by which our producing troubles were practically ended.

As our business is growing rapidly and the demand for gages, taps, screws, etc., is growing to where it will be eventually beyond our present equipment to supply it, and as we do not wish to increase this equipment because our records show that it costs us considerably more on the non-productive side of the business to do these things ourselves than to buy of others, we are receiving the new universal interchangeable A. S. M. E. standard with open arms, hoping that we will be able to buy taps, dies, screws, gages, etc., made according to this decimal system, which will be sufficiently good for our less particular classes of work at least, and which will still be more or less in conformity to the same standard as applied to our better classes of work. We have, however, decided to make our own master reference gages, a good many working gages and also taps and dies enough to start us along the right path before doing any outside buying.

After completing our first set of gages we are suddenly brought face to face with a condition which makes us feel weak in the knees, a nervous affection which oftens accompanies clear "hind-sight." Through lack of as clear fore-sight, or rather from a false sense of security we went ahead, made elaborate but necessary arrangements for a better job than we had ever done before at a very considerable expense, and now find that our measuring arrangements, pitch micrometers, wire system, ball points and all, do not measure as the figures given by the society in their reports indicate that threads should be measured. That is, the society diagrams and figures show that the 60-degree angle of the thread should be measured *parallel to the axis* and at an *angle to the helix* of the thread equal to the angle of the lead. Our measuring arrangements all measure at *right angles to the helix* or at an *angle to the axis* equal to the angle of the lead of the thread.

What brought this to light and proves this matter to be quite serious in connection with accurate gage making is that we had two duplicate (?) thread plugs made and on checking their pitch diameters with the wire system we found them identical, and perfect in lead, outside diameter, etc., but found, when measured for pitch diameter with a thread micrometer, a difference was plainly discernible, and further that when a thread templet was adjusted to the one, the other either entered loosely or not at all.

The cause of the trouble was found to be in a new thread tool made with a cutter head which swiveled vertically and which had been left for trial by a salesman with the head gage maker, he had tried it out with the top face of the cutter horizontal for one gage and had inclined it to conform to the helix for the other working the pitch diameter by the wire system.

To satisfy myself that there was no other cause for the trouble I had a number of gages made under both conditions, and though we had no trouble in checking gages made with the tool in the same position, with each other by the various measuring methods, we found that when both gages fitted the templet they gave different comparisons with the wire system and thread micrometer, and when they checked together with the wires, a different result was obtained with the micrometer, and *vice versa*.

Now, where are we at? The society gives us theoretical figures to follow based on one system; measuring-tool manufacturers and any readily applicable methods of measurements give us a practicable way to measure threads based on a radically different system, and along comes an obliging thread-tool manufacturer who puts the means in our hands to follow either system we choose.

Which way, gentlemen, which way do we jump?

Forthcoming Meetings

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

National Gas and Gasolene Engine Trades Association, meeting, June 22, 23, 24, South Bend, Ind., headquarters, Oliver hotel. Albert Steltwatter, Cincinnati, Ohio.

Society for the Promotion of Engineering Education, seventh annual convention, June 24-25-26, Columbia University, New York, and Pratt Institute, Brooklyn, N. Y. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

The Society of Naval Architects and Marine Engineers, summer convention, June 24-26, Detroit, Mich., headquarters, Hotel Pontchartrain. W. J. Baxter, secretary, 29 West Thirty-ninth street, New York City.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J., Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

Business Items

Farrel Foundry and Machine Company, Ansonia, Conn., has opened a branch office at 1011 Williamson building, Cleveland, O., George W. Oshorne, manager.

The Jacobs Manufacturing Company, Hartford, Conn., manufacturers of drill chucks, is putting in additional machinery and enlarging its capacity to take care of the increased demand for its product.

Business Opportunities

The Grand Rapids (Mich.) Stove Company will enlarge its plant.

The Gemmer Engine Company, Pontiac, Mich., will erect a new shop.

The Marietta (Ohio) Chair Company is to erect a new six-story factory.

The Atlas Flour Mills, Milwaukee, Wis., is adding two stories to its mill.

The Cleveland (Ohio) Electric Illuminating Company will build an addition.

The Boyne City (Mich.) Tanning Company will erect an addition to plant.

The Melville Woolen Company, Fredericksburg, Va., will erect an addition.

The National Cycle Works, Bay City, Mich., will build two additions to plant.

The Lewis Knitting Company, Janesville, Wis., will erect an additional factory.

The foundry and machine shop of J. S. Getchell & Sons, Caribou, Me., was burned.

The Acme Universal Joint Company, Kalamazoo, Mich., will erect a new factory.

It is said a new building will be built for the Barnes Gear Company, Oswego, N. Y.

Albert Trostel Sons' Leather Company, Milwaukee, Wis., is building an addition.

Crohon & Roden Company, Grand Rapids, Mich., will erect a large new tannery.

The Christianson Metal Shoe Company, Racine, Wis., will build a new factory.

The Watertown (Wis.) Gas and Electric Company will erect a new power house.

L. W. Weyenburg Shoe Company, Chippewa Falls, Wis., will erect a five-story factory.

The Barnum Trunk Company, Minneapolis, Minn., will erect a new three-story factory.

Luther Lindauer, South Kankanna, Wis., will build pulp mill at Little Rapids, Wis.

The tannery of the E. C. Fisher Company, Bethel, Vt., recently burned, is to be rebuilt.

The Enamel Steel Closet Tank Company, Kalamazoo, Mich., will erect a new building.

The Bessemer Gas Engine Company, Grove City, Penn., will erect an addition to plant.

James D. Flynn, of Ardmore, Okla., is to establish a $50,000 foundry at Sapulpa, Okla.

The foundry at the penitentiary at Salem, Ore., recently destroyed by fire, is to be rebuilt.

The Seibert Johnson Company, Hudson, Wis., will build addition to sash and door factory.

The Rochester (N. Y.) Railway and Light Company will erect an electric automobile repair shop.

J. G. Oberhelman, Cincinnati, Ohio, will erect a new foundry in the Camp Washington factory district.

The Handknit Hoisery Company, Sheboygan, Wis., will build a new factory to cost about $10,000.

The Metric Metal Company, Erie, Penn., manufacturing water and gas meters, is enlarging its plant.

The Hawkeye Pearl Button Company, Muscatine, Iowa, will establish a branch business in Keokuk.

The Vans Harbor (Mich.) Land and Lumber Company will erect a new mill to replace the one burned.

The Dublin (Ga.) Buggy Company is to build an addition and engage in the manufacture of automobiles.

The Chippewa Falls (Wis.) Woolen Company will build a new mill and also two-story addition to boiler room.

Henry Disston Sons, of Philadelphia, Penn., manufacturing saws, files, etc., are to erect a plant in Toronto.

The Nordyke & Marmon Company, Indianapolis, Ind., is in the market for new tools for automobile work.

The Virginia Mechanics' Institute, Richmond, Va., is to install a machine shop and blacksmith shop this summer.

The Freeland Steam Tank Company, Sturgis, Mich., will locate at Portage, Wis. New buildings will be erected.

C. C. Waller, Krupp & Tuffly building, Houston, Tex., is said to be interested in plan to establish $300,000 car works.

The Twin City Stone Company, Marinette, Wis., will erect building for manufacturing concrete blocks, etc.

The Mesaba Iron Works, Virginia, Minn., is erecting a new plant, including foundry, machine shop and forge room.

The Western Motor Company, Logansport, is not moving its plant to Marion, but erecting an additional factory.

E. J. Vandreuil, Two Rivers, Wis., will build a canning factory near Warrens, Wis. The town is to be called Vandreuil.

The plant of the California Fruit Canners' Association, at Fresno, Cal., was destroyed by fire. Loss, about $500,000.

The Massillon (Ohio) Rolling Mill Company, it is said, will enlarge capacity of plant by the addition of more steel mills.

The Bury Compressor Company, Erie, Penn., is in the market for a gas engine, to run its contemplated addition to shop.

The lumber and shingle mill of Smith, Hurst & Schneider at Grand Marais, Mich., was destroyed by fire. Loss, $10,000.

The Heywood Manufacturing Company, Minneapolis, Minn., making paper boxes, etc., will erect a new $150,000 factory.

Gotfredson Bros., Green Bay, Wis., will erect a central heating plant and will also include an auto garage, paint shop, etc.

A new brick plant is to be established near St. Ignace, Mich. M. Van Orden, Houghton, Mich., is president of the concern.

The A. O. Smith Company, Milwaukee, Wis., manufacturing automobile parts, will erect a new plant to cost about $500,000.

The sawmill, planing mill and dry kilns of the Skagit Mill Company, Lyman, Wash., were destroyed by fire. Loss, about $100,000.

The Maxwell-Briscoe Company, New Castle, Ind., is inquiring about lathes, milling machines, etc., for a proposed enlargement of its plant.

The plant of the Pittsburg-Hickson Bedstead Company, at East Butler, Penn., is to be enlarged by the erection of two additional buildings.

Plans have been prepared by John H. Windrim, architect, Philadelphia, Penn., for addition to foundry and shop building at Girard College.

The Rockwood Mills, Rockwood, Tenn., will build a $11,000 addition to its mill and also install machinery for the making of paper boxes.

The Orono (Me.) Pulp and Paper Company is building an addition to its mill to be used as a boiler room. New boilers will be installed.

The Williams Foundry Company, Vineland, N. J., is erecting a new foundry. The company makes a specialty of knitting-machine castings.

The Marsden Brass Foundry Company, Milwaukee, Wis., is building a new foundry for the manufacture of aluminum brass and bronze castings.

The Interborough Rapid Transit Company New York, has taken out a permit for new barns and shops to replace those recently destroyed by fire.

It is reported the mechanical engineering department of the University of Arkansas, Fayetteville, Ark., contemplates the installation of new equipment in shops and laboratory.

The Armstrong Buggycar Company, Atlanta, Ga., a new concern, will erect plant and install automobile machinery to cost $10,000. D. D. Armstrong, Century building, is manager.

The Valk Manufacturing Company is erecting a plant at Topeka, Kans., for manufacturing mining and irrigating pumps, gas and gasolene engines. About $200,000 is to be expended.

The Davenport (Iowa) Ice Chipping Machine Company has taken over the gasoline engine business of the White Lily Washer Company and expects to erect a new factory in the near future.

A. R. Weiss, Maximilianowskaja 12, Moscow, Russia, agent, would like catalogs of automobiles, agricultural machinery, railway tools and supplies, machine tools, miners' tools, fuel economizers.

The Morris Sherman Manufacturing Company, Chattanooga, Tenn., will start erection of proposed new plant to replace the present one. The company manufactures boilers, structural steel, etc.

J. F. Rothe, Green Bay, Wis., will purchase within 60 days following foundry equipment: Cupola, furnace blower, rattler, electric elevator, 10-ton electric crane, nine electric motors, 3 to 25 horsepower.

M. E. Varadachariar, agent of the Conjeeveram Industrial Company, Ltd., Conjeeveram, near Madras, India, would like catalogs and price lists of agricultural implements, brick and tile machinery and pumps for irrigation.

Herman Sielcken, of Crossman & Sielcken, coffee importers, New York, has bought the Woolson Spice Company, at Toledo, Ohio, and will build a new plant, which, it is said, will be the largest coffee roasting plant in the United States.

J. L. H. Smits & Co., Warmoesstraat No. 42, Amsterdam, Holland, dealers and agents, are open for business in the following goods: Machine tools, woodworking machinery, small tools, drills, emery wheels, belting, pumps, pipes and fittings.

The Electric Welding Products Company, Cleveland, O., has just completed a new three-story addition to its plant which will give it nearly double the present manufacturing floor space. The greater part of this new addition will be equipped to handle gas-engine and motor-car parts.

The American Automatic Stoker Company is negotiating for a site for plant in Blomington, Ill., the company's product now being made by outside parties. D. W. Ross, 165 Broadway, New York, is president, and J. J. Hannahan, Railway Exchange building, Chicago, is general manager.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., July 19, for machinery for central pumping station and three pumping units for hydraulic excavating and sluicing, including pumps and motors, engines, boilers, monitors, pipes and fittings, etc. as per Circular No. 516.

The Puget Sound Machinery Depot, Seattle, Wash., is in the market for machinery for its new shop, including 72-inch vertical boring mill, 36-inch triple geared lathe, 18-inch quick change lathe, 24-inch turret lathe, 48-inch by 14-foot planer, one side; 24-inch shaper, drills, keyseater, plulley lathe and power hack saw.

The Portland (Ind.) Foundry and Machine Company has voted to increase its capital stock for the purpose of building a new plant, to consist of grey iron foundry, machine shops, boiler shops and supply store. It will add a drop forging plant later. The firm would like to hear from manufacturers of modern equipment.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: June 22—Crucibles, water gages, thermometers (schedule 1330); rail cutting machine (schedule 1326); fan motors (schedule 1325); differential blocks (schedule 1330); steel bolts, reamers, beam scales, machinists' vises (schedule 1323); hose clamps,

Oxhydric Process of Cutting Metals

Torches and Machines Used for Cutting Steel. Amount of Gases Consumed for Different Thicknesses of Metal and Sizes of Pipe. Time Used

BY E. F. LAKE

It is seldom that the AMERICAN MACHINIST has the privilege of publishing such a striking addition to machine-shop methods as the one which supplies the subject of this article. When we say that Fig. 1 represents a piece of 9-inch chrome-nickel steel armor plate which has been cut to a circular outline by the removal of the waste piece shown in the left foreground, and that this has been done at the rate of a linear foot of cut in 2¼ minutes, we think we are saying enough to indicate that here is something new in the machine shop.

FIG. 1. A 9-INCH NICKEL CHROME-STEEL ARMOR PLATE AFTER ONE-HALF THE CIRCLE HAS BEEN CUT AT THE COCKERILL WORKS, SERAING, BELGIUM

Figs. 2 and 3 are added, the former to show the arrangement of the apparatus preparatory to the cut and the latter to show the work in progress with the pyrotechnic display that accompanies it. Further on in this article additional examples of the work done will be shown which are less striking than the one which forms the subject of the first three pictures only because of the smaller sizes of material acted upon. In some respects—notably the form of the cut made in some of the examples—these latter cases are, indeed, more striking than the ones shown in Figs. 1, 2 and 3.

The remarkable results are obtained by an apparatus which is a development from one patented in 1901 by the Cologne-Meusen Mining Company for opening plugged blast-furnace tap holes and now in considerable use in this country, where it has cut tap holes through 4 feet or more of solid metal, and with a reduction of time from days to as many hours. That apparatus, like this, makes use of two nozzles through one of which a mixture of oxygen and hydrogen is supplied, while the other delivers pure oxygen only. The action of the older apparatus is, however, to actually melt the metal, and while very effective for its purpose, it is by it impossible to produce a smooth and exact cut of any desired length.

With the present apparatus a preheating nozzle, shown at the right of Fig. 6, delivering mixed oxygen and hydrogen, is used to continuously heat the metal to the required temperature, while immediately following it, and set at an angle such that both streams of gas strike the metal at the same place, is a second nozzle delivering pure oxygen only. This cuts the metal by oxidizing it without melting and blows away the oxides by the force of the blast. The result is a cut which may be fairly compared with that made by a cutting tool, as shown in Fig. 5, while the heating is so local that the properties of the material cut are not affected beyond about 1/64 inch of the cut surface and the width of the kerf is surprisingly small.

The oxhydric process is based on the well known fact that iron burns easily and rapidly in an atmosphere of oxygen gas, as much heat is thus set free. If we throw a jet of oxygen upon iron that has been heated to a red, the oxygen oxidizes

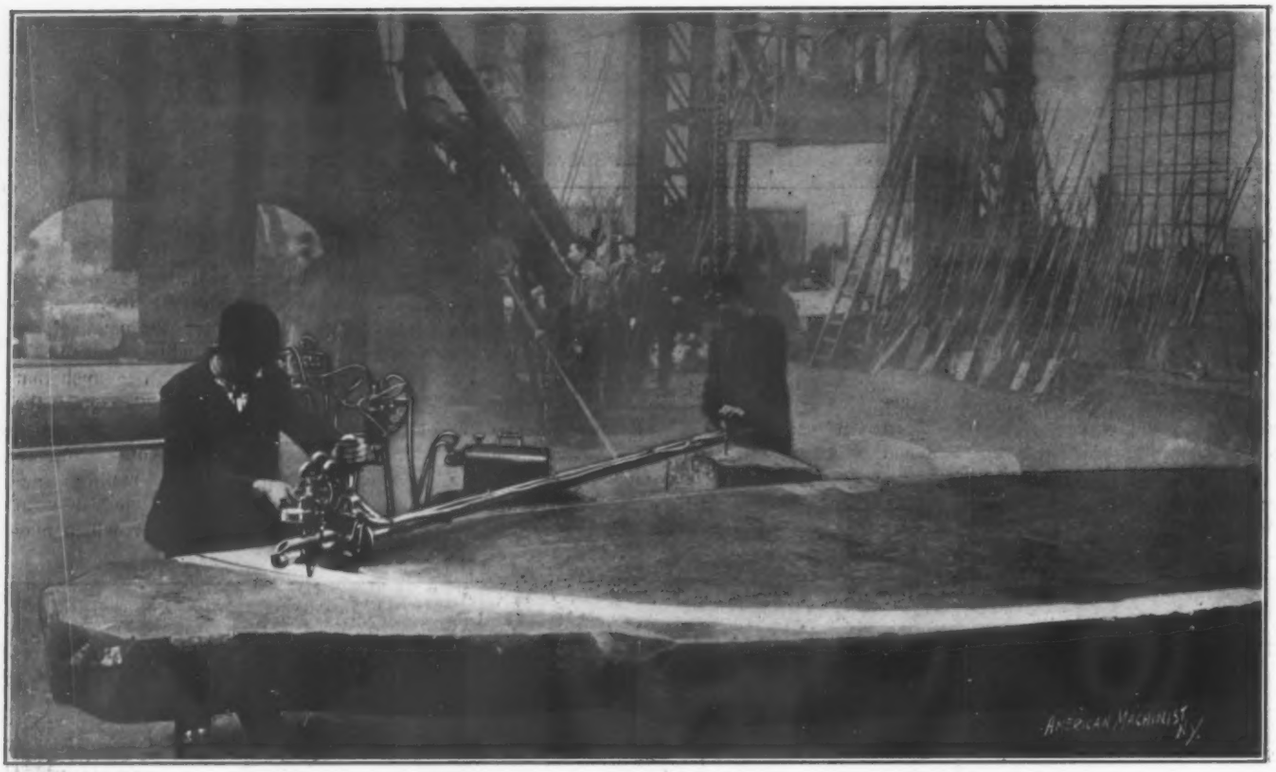


FIG. 2. GETTING READY TO MAKE THE CUT WITH TRAMMEL POINT AND BEAM MACHINE

the metal, which is to say, burns it. Thus the steel is heated only to from 1300 to 1500 degrees Fahrenheit, as at this temperature iron has a great affinity for oxygen, and the combination produces different forms of oxides.

What the New Torch Does

The double-nozzle torch may be manipulated by hand, or it may be guided by

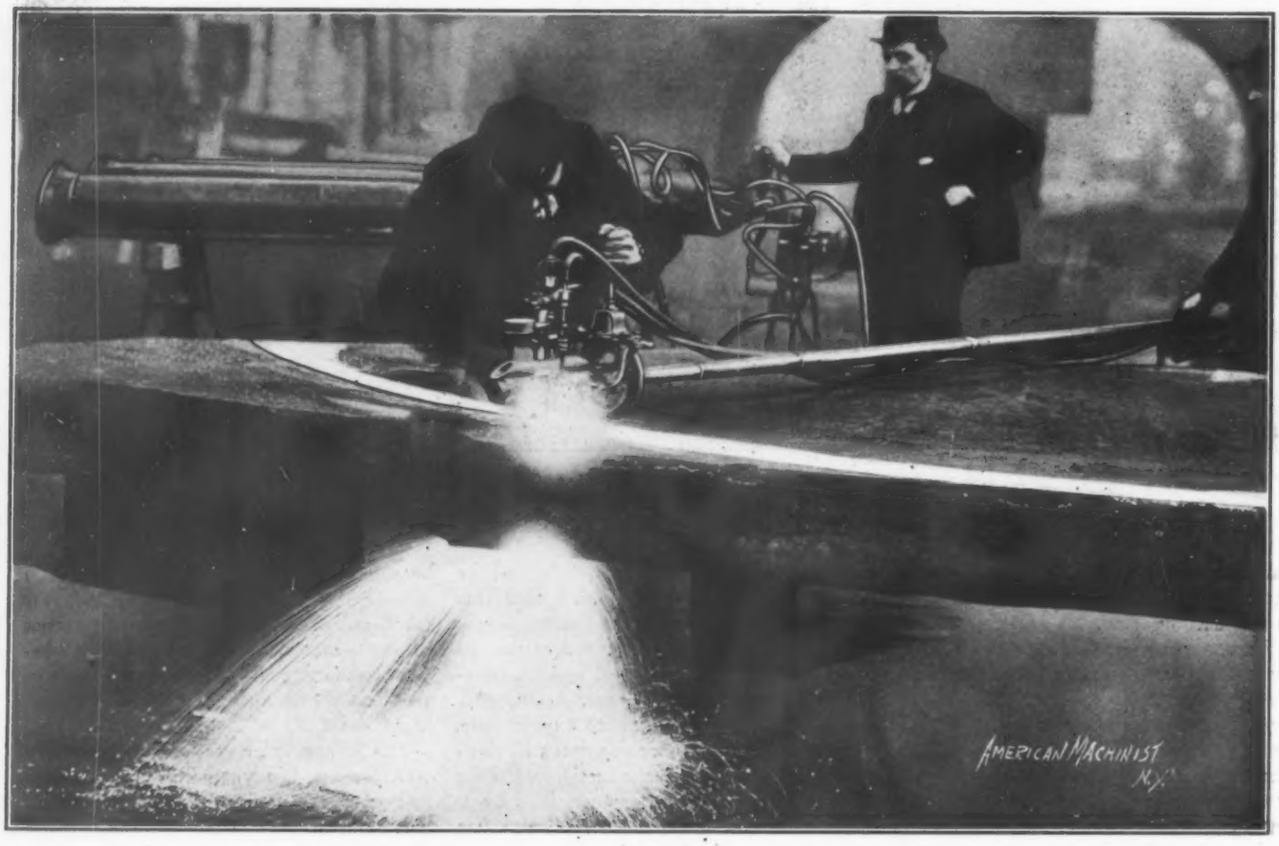


FIG. 3. CUTTING THE 9-INCH NICKEL CHROME PLATE AT RATE OF 2¼ MINUTES PER LINEAL FOOT

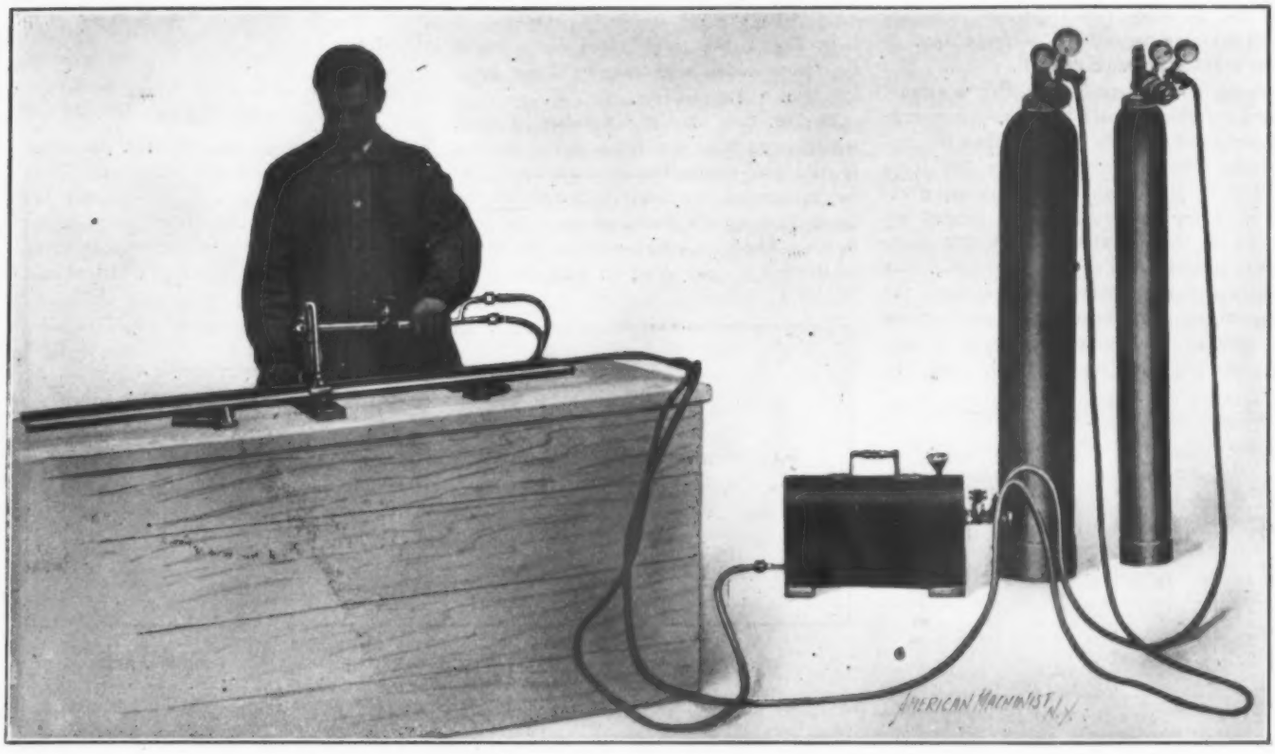


FIG. 4. OXHYDRIC APPARATUS WITH MECHANICAL APPLIANCE FOR CUTTING IN A STRAIGHT LINE

any sort of mechanical arrangement; and thin sheets or thick plates, steel tubes, structural shapes, castings, or any odd pieces of steel may be easily cut.

The cut can be made to follow any sort of a line whatever, as all forms of curves and odd shapes are cut as easily as the straight line. The cut is not necessarily square to the surface, as a beveling cut can be easily made, and it is practically no wider at the bottom than at the top even when cutting very thick metal. The speed of travel of the torch can be made about 8 inches per minute on fairly thick metal, and this makes it compare very favorably with hot sawing.

The composition of the steel, or its mechanical treatment does not affect the speed with which the metal is cut, or the amount of gas which is used in the cutting. In fact, there is no variation between the rolled, forged, or cast steels, or the soft, hardened, tempered, carbonized or Harveyized steel, and a nickel chrome, high-manganese or high-carbon steel cuts as easily as the low-carbon steels.

Complete Apparatus for Cutting

The complete apparatus for cutting, with one of the mechanical appliances for guiding the torch, is shown in Fig. 4. The two steel bottles at the right of the picture

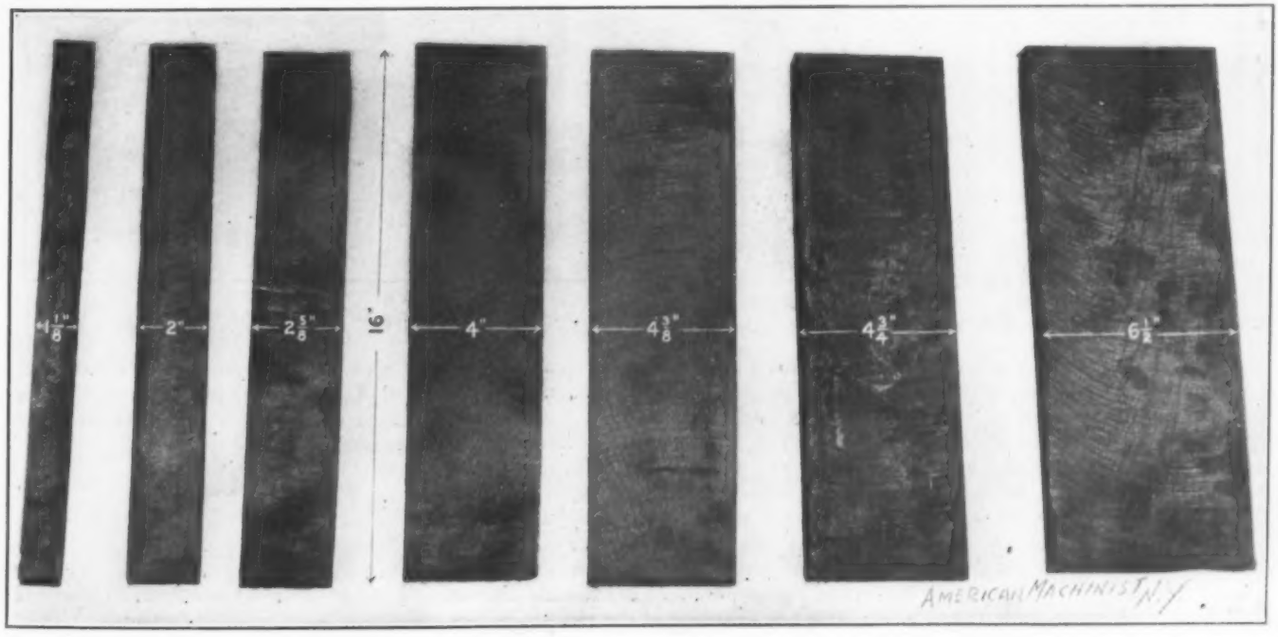


FIG. 5. CUT SURFACE OF STEEL SLABS, FROM 1⅛ TO 6½ INCHES THICK, CUT WITH MACHINE IN FIG. 4

contain the oxygen and hydrogen which is stored under a pressure of from 1500 to 2000 pounds per square inch.

Each bottle is provided with a needle valve to which is attached a pressure regulator governing the flow, so that the gas will be delivered to the mixer and from thence to the torch at a constant pressure. A high-pressure gage is located between the needle valve and pressure regulator in order to show at all times the contents of the tank and to determine the amount of gas consumed in any cutting operation. A low-pressure gage is also attached to the regulator showing the pressure of gas as used for cutting. The cutting pressure can thus be varied to suit the character of the work by turning a thumb screw on the regulator. From the regulator the gas is conducted by heavily armored rubber tubing to the mixer.

The mixer is shown on the floor beside the bottles and the gases are conducted through it by a conical worm-shaped pipe made of thin metal, this pipe being surrounded by cool water as a safety provision against explosion of the mixed gases.

Number of Piece Counting from the Left.	Thickness of Metal in Inches.	Consumption of Gas for Each Lineal Foot of Metal Cut.	
		Oxygen.	Hydrogen.
1	1½	3.9	3.9
2	2	4.8	4.8
3	2½	8.3	5.8
4	4	14.4	7.7
5	4½	15.5	8.8
6	4¾	17.5	9.0
7	6¼	22.3	10.3

TABLE 1. GASES USED IN CUTTING SLABS SHOWN IN FIG. 5.

Thickness of Metal, Inches.	Size of Nozzle for Cutting or Oxygen Torch, Inches.	Size of Nozzle for Heating or Oxhydric Torch, Inches.	Cubic Feet of Gas Used for Each Lineal Foot of Metal Cut.	
			Oxygen.	Hydrogen.
0.2	0.06	0.12	1.5	1.5
0.4	0.06	0.12	1.9	1.9
0.6	0.06	0.12	2.2	2.2
0.8	0.06	0.12	2.5	2.5
1.0	0.08	0.16	2.9	2.8
1.2	0.08	0.16	3.3	3.2
1.4	0.08	0.16	3.8	3.4
1.6	0.08	0.16	4.4	3.6
1.8	0.08	0.16	5.1	3.8
2.0	0.08	0.16	5.8	3.9
2.2	0.08	0.16	6.5	4.1
2.4	0.08	0.16	7.2	4.3
2.6	0.08	0.16	8.0	4.6
2.8	0.08	0.16	8.8	4.8
3.0	0.08	0.16	9.7	5.0
3.2	0.08	0.16	10.7	5.3
3.4	0.08	0.16	11.8	5.6
3.6	0.08	0.16	12.8	6.0
3.8	0.08	0.16	13.9	6.4
4.0	0.08	0.16	15.0	6.9
4.2	0.08	0.16	16.2	7.4
4.4	0.08	0.16	17.5	8.0
4.6	0.08	0.16	18.8	8.5
4.8	0.08	0.16	20.2	9.0
5.0	0.08	0.16	22.7	9.5

TABLE 2. AMOUNT OF GAS AND SIZE OF TORCH USED WHILE CUTTING STEEL FROM $\frac{1}{16}$ TO 5 INCHES THICK.

Cutting off Slabs of Steel

In Fig. 4 the torch rides on a frame that is provided with two ways for guiding it in a straight line.

In Fig. 5 is shown a number of slabs which have been cut from plates ranging from 1⅛ to 6½ inches in thickness. The cut surface of the slabs is shown and the lines showing the travel of the torch can be seen. On steel 4 inches thick, the width of the cut is only ⅛ of an inch, while on thin metal it is but 5/64 inch, and the metal is practically as smooth as that coming from a saw.

The principal item in the cost of cutting metal with this process, is the gases used, as the apparatus is much simpler than that used for cutting metals by any other means, and requires no power, and the time of cutting is as quick if not quicker. The consumption of gas naturally depends upon the thickness of the piece to be cut. The amount of each gas used, as well as the thickness of metal of the pieces that were cut, as shown in Fig. 5, is given in Table 1.

Gas Consumption for Steel up to 5 Inches Thick

From the large amount of work which has been done and the numerous thicknesses of metal which have been cut, the amount of gases which should be used are pretty well known. In Table 2 is given the amount of the two gases which should be used for all thicknesses of metal from 1/10 of an inch to 5 inches, as well as the size of nozzle which should be used for each gas.

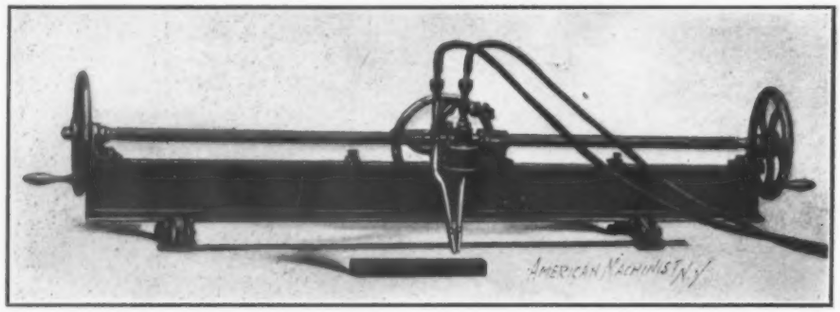


FIG. 6. MACHINE FOR MOVING TORCH LONGITUDINALLY OR AT RIGHT ANGLE

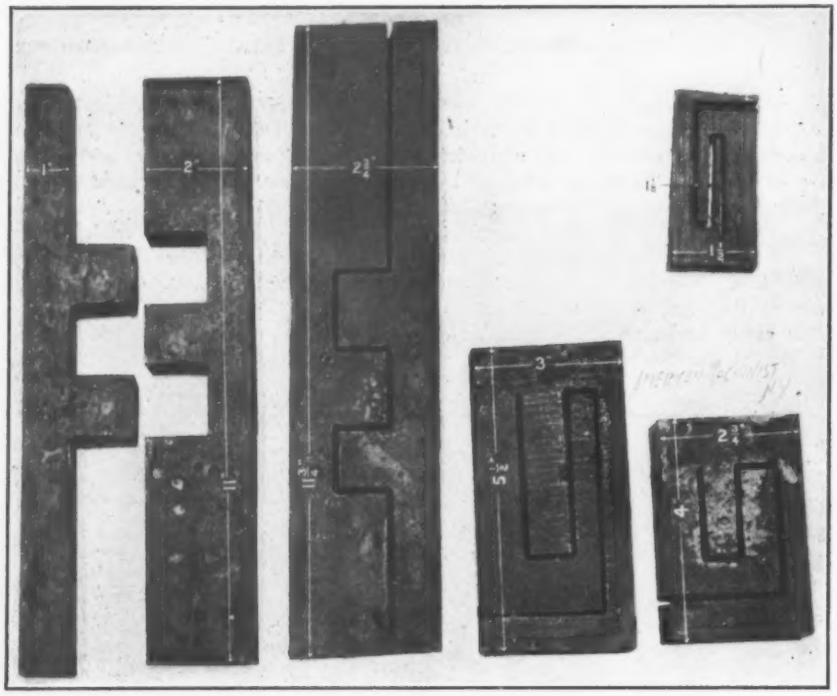


FIG. 7. IRREGULAR SHAPED CUTS MADE WITH MACHINE IN FIG. 6

Right Angle Cuts

In Fig. 6 will be seen a machine which is designed for accurate straight cuts either parallel with, or at right angles to the bed of the frame. The torch is mounted on a carriage which is moved longitudinally by hand wheels and a lead screw. Another hand wheel on the side

of the carriage moves the torch away from or toward the machine, and as the oxygen nozzle should always follow the pre-heating nozzle, the torch may be turned around by the small lever shown. The torch, as are all the torches, is provided with a valve for shutting off the gas. At the bottom of the machine is located a straight edge on which the nozzle slides. By means of an additional attachment that is not shown, the torch can be made to cut in a vertical direction.

FIG. 8. APPLIANCE FOR CUTTING CIRCLES WITH BRACE

FIG. 9. TRAMMEL POINT ON BEAM FOR CUTTING LARGE CIRCLES

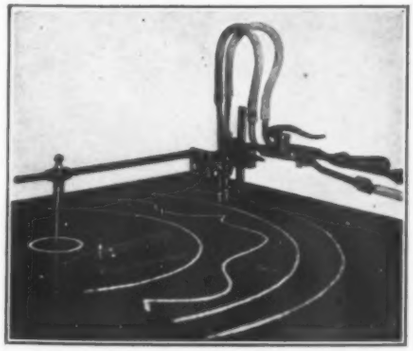


FIG. 11. ANOTHER MACHINE CUTTING REGULAR AND IRREGULAR CURVES

In Fig. 7 are shown some samples of the work done with the above machine. The slabs themselves were first cut off with the oxhydric torch, and afterward the irregular cuts were made in the slabs. The narrowness of the cut, the square corners that it is possible to turn, and the fact that the metal is not burned on the sides of the cut are plainly seen.

The closeness with which the metal can be cut to a line is best illustrated by the small slab in the upper right-hand corner. In the center of the slab it will be noticed that there has been left a thin strip of metal. This is but ⅛ of an inch thick, while the cut is 1¼ inches deep, and is practically no wider at the bottom than at the top.

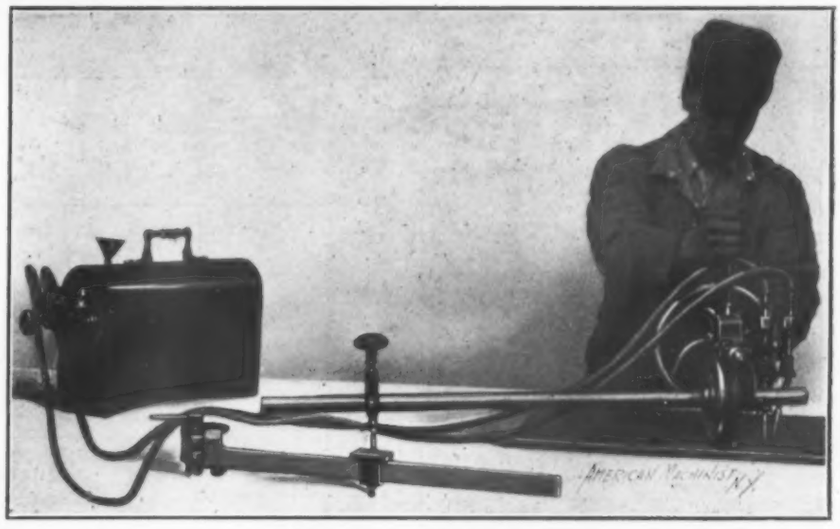


FIG. 10. MACHINE FOR REGULAR OR IRREGULAR CIRCULAR CUTTING

Cutting Regular and Irregular Curves

By Fig. 8 is shown an appliance which can be used in an ordinary brace for cutting circles from 2 to 12 inches in diameter and in Fig. 9 is shown the apparatus that can be attached to a beam located in a trammel point for cutting large circles. It will be noticed that the torch is fastened by thumb screws to two U-shaped rods that are mounted on wheels. Either of these rods, or both together, can be raised or lowered so as to accommodate the torch to any inequalities in the surface of the metal, or to locate it the proper hight above the metal for successful cutting.

A machine for regular and irregular circular cutting is shown in Fig. 10. In this the hand wheel is used to turn the wheel, located on the trammel beam, by worm gearing, and thus give the torch a steady travel around the centering trammel point.

A slot is cut in the end of the beam so the operator can move the torch back and forth while he is moving the whole machine in a circle. The torch can also be revolved on 45 degrees of a circle so the heating nozzle can be kept in front of the oxygen nozzle.

By Fig. 11 is shown another machine for cutting regular or irregular curves together with some of the curves which have been cut. There is a small wheel located on a bar near the nozzle of the torch and this can be raised or lowered to locate the torch at its proper distance above the plate. The torch can be swung around so as to always keep the heating nozzle ahead of the oxygen nozzle. The apparatus is provided with an extra guide wheel, and an adjustable point which can be used where the guide wheel would interfere with the cut.

Cutting Steel Tubes

One of the most useful applications of this process is in the cutting of steel tubes or pipe. A special attachment has been made for this purpose, which is shown in Fig. 12. It is made in several sizes to accommodate the different sizes of pipe.

The pipe is inserted in the center of a ring and is clamped there by three set screws. The torch is then revolved around the pipe and cuts it with a good clean cut and hardly any waste of metal. A small wheel, that runs around the pipe back of the nozzles, locates their position and adjustment can be obtained by means of a spring inside of the apparatus. This apparatus is especially valuable in plants where power is not available. The cost of cutting pipe by this process can be obtained from Table 3, which gives the amount of gas consumed when cutting

pipe from 2 to 12 inches in diameter and from 3/32 to 5/16 of an inch thick.

Manhole, Rivet Head and Pipe-cutting Machines

Another style of pipe-cutting machine is built, which can be used on pipe that has flanges on both ends, and it is made so it can be adjusted to fit different diameters of pipe. This machine can be used for cutting the openings for branch connections. Branch flanges can also be cut out.

A manhole-cutting machine is also made which will cut oval, round and square holes up to 8 inches square or diameter. An elliptical segment which guides the cutting nozzle is applied to the cutting of oval holes in sizes from 2½ to 24 inches, and another corresponding segment is inserted into the machine for cutting round or square holes. This machine is very handy for boiler or machine shops, and a rivet head-cutting machine is built which is very handy for the boiler shop.

Cutting Up an Armored Cruiser

One of the most interesting jobs which has been done with this process was the taking apart and cutting into scrap of an old English armored cruiser, which had been bought by a firm in Hamburg.

The method which had been employed formerly was to cut the rivets off, drive them out, remove the armor plate, notch it with compressed air tools and then break it up under a drop. To complete the work by this old method usually took 1½ years.

FIG. 12. END VIEW OF PIPE-CUTTING MACHINE

FIG. 13. CUTTING CAST-STEEL FRAME FOR PROPELLER SHAFT

FIG. 14. CUTTING 18-INCH PROPELLER SHAFT IN 17 MINUTES

Thickness of Metal.	Outside Diameter of Tubes in Inches.																		
3/32 to 1/8	2	2½	2½	3½	3½	4½	4½	5½	5½	6½	6½	7½	7½	8½	8½	9½	10	10½	12
1/8 to 3/16																			
3/16 to 1/4																			
	Cubic Feet of Gas Consumed.																		
Oxygen	2.3	2.6	3.2	4.5	5.2	5.9	6.6	7.4	8.1	8.8	9.5	14.4	15.3	16.3	17.3	18	19	21.5	24
Hydrogen	7.4	8.7	10.4	13	18	20.5	23	25.5	28	30.5	33	50	53.5	57	60.5	66	70	75	83

TABLE 3. AMOUNT OF GAS USED FOR CUTTING AND WELDING TUBES FROM 2 TO 12 INCHES DIAMETER.

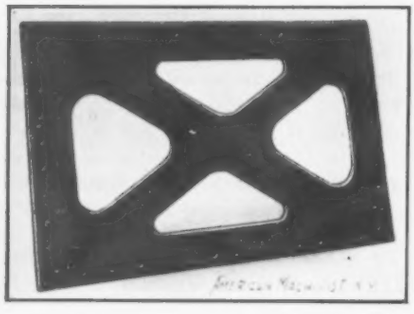


FIG. 16. HOLES CUT IN PLATE 4X6 FEET, 9/16 INCH THICK

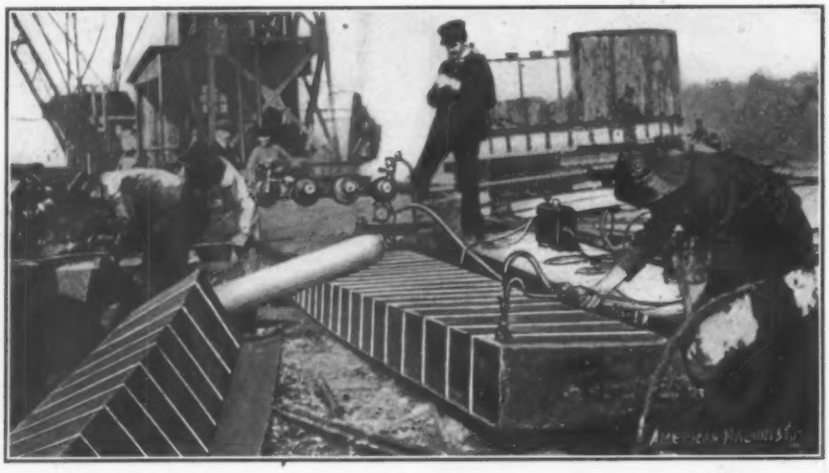


FIG. 15. CUTTING UP THE ARMOR PLATE, SOME OF WHICH WAS 14 INCHES THICK

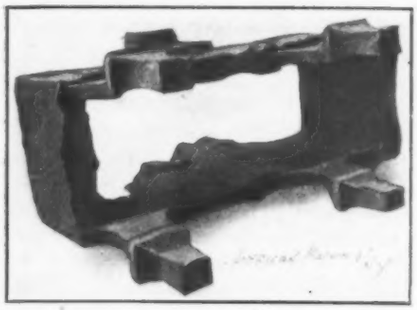


FIG. 17. STEEL CASTING AS IT LEFT THE MOLD

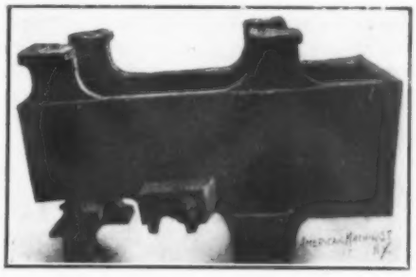


FIG. 18. SAME CASTING AFTER CUTTING RISERS, SPRUES, ETC.

FIG. 19. STEEL CASTING AS IT LEFT THE SAND

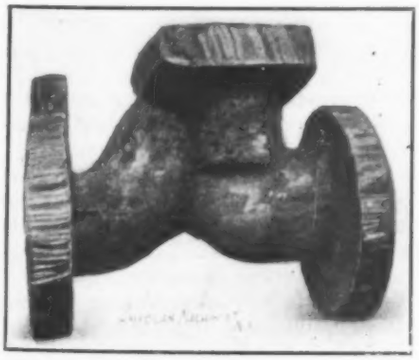


FIG. 20. SAME CASTING AFTER CUTTING OFF EXCESS METAL.

Now, with the oxhydric process, the job was completed in 2½ months.

In Fig. 13 the hull of the boat partly dismantled, is shown, and to the right of the picture, the workman is seen cutting up the cast-steel frame for the propeller shaft. The propeller shaft is shown, as it was being cut up, in Fig. 14. It was 18 inches in diameter and the cuts were made in 17 minutes.

The armor plate, as it was being cut up, is shown in Fig. 15. Some of this was 14 inches thick and some of the heaviest guns which were cut up had an outside diameter of more than 40 inches. All the metal in the boat was cut to sizes suitable for charging in the furnaces for remelting.

Cutting Plates and Steel Castings

As a manufacturing proposition, the oxhydric process is equally as good as in the cutting up of scrap and Fig. 16 shows a sample of work on which it is very useful. This is a face-plate for the base frame of a locomotive. It was 9/16 inch thick, 4 feet wide by 6 feet long and about 264 lineal inches had to be cut in cutting out the opening. This work was done in exactly one hour, which is at a speed of 3¾ minutes for each running foot.

Many uses for this process will also be found in steel foundries. In Fig. 17 is shown a steel casting just as it comes from the mold, and Fig. 18 shows the same casting after the sprues, rises, etc., have been cut off with the oxhydric process. Fig. 19 shows another steel casting as it came from the sand, and Fig. 20 shows the same casting after the surplus metal has been cut off.

Autogenous or Fusion Welding

The oxhydric process is also applicable for welding the various metals that can be fused together. The flame, however, must be the opposite of that used for cutting metals, as it must be one that freely reduces the oxide, rather than one causing oxidation, as is used in cutting, as oxides in the welds are inadvisable.

The apparatus used for welding is shown in Fig. 21. By this it will be seen that the same two oxygen and hydrogen bottles are used and that the gas is piped from these to the same mixer that is used in cutting. Here, however, the similarity ceases as the extra nozzle for oxygen is not used. A torch with a single nozzle is substituted and the gas that enters the torch is piped through a single pipe from the mixer; thus only one line of armored hose, leading to the torch, is needed in place of the two.

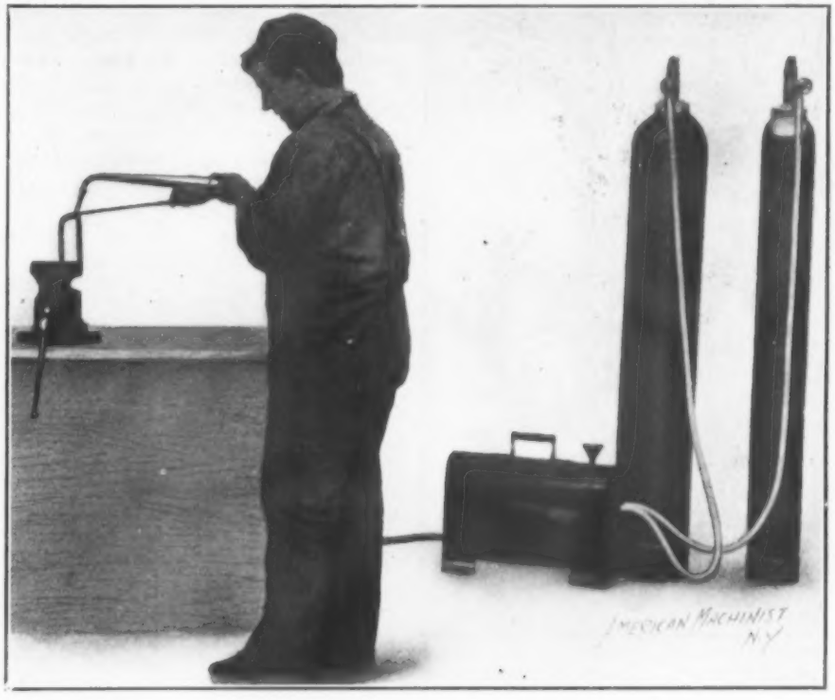


FIG. 21. THE OXHYDRIC WELDING APPARATUS AT WORK

The Welded Joint

The welding done by this method leaves the metal its ductility. If the welded joint is submitted to a slight hammering, while it is cooling down to a dull red, or even to a heat treatment after it has cooled, the steel in most cases can be brought back to its original structure and the joints can be made nearly as strong as the original metal.

In welding thick plates, say from ⅜ inch upward, by any of the fusion methods, it is usual to bevel or chamfer the two edges of the joints and fill the V thus formed by melting metal from a rod, with the torch. If the metal is properly fused by this method a fairly good joint is obtained, but if the operator allows globules of metal to fall from the rod and drop

on metal which has not been properly melted, the two do not fuse together and a poor joint is the result.

Welding Thick Metal

The German Oxhydric Company adopted a different method of welding metals from ⅜ to 1 inch thick, and have made many successful welds thereby. This method is to put the two ends of the metal together without overlapping, but in contact with each other. They are thus heated by two oxhydric torches, one above and the other below the metal, and exactly opposite each other, and are given as extensive a heating zone as possible.

When the metal begins to show signs of melting on the outside, the interior of the sheets are doubtless at a white welding heat; the torches are then removed and an anvil and hammer brought into

FIG. 22. WELDING LEAVES AND PETALS ON BLACKSMITH'S ART WORK

use for lightly hammering the joint. This causes a readjustment of the molecules, and they join together in the weld.

The Welding Gases

In welding, one part of oxygen to from four to six parts of hydrogen are used, and it is necessary to obtain a complete absorption of the oxygen, by the hydrogen in excess, in order to make a perfectly homogeneous flame. This was a difficult problem to solve as the fear of explosion long prevented the mixing of the two gases before their inflammation.

It was overcome by assuring to the mixture of the gases a velocity greater than the velocity of the propagation of the flame, as an explosive mixture contained in a tube does not ignite instantaneously in all of its mass when combustion is started at one end of the tube.

The ignition is propagated in the tube with a finite velocity which increases as the square of the section thereof. If, therefore, the gaseous mass moves toward the point of ignition with a speed greater than the speed of propagation, the flame will not reach the inside of the torch and much less that of the mixer.

Thus, having obtained a minimum for the speed to be given the gas, it is necessary not to exceed the maximum, and this is obtained by a practical consideration, namely, that the jet of gas leaving the torch must not be strong enough to set in motion the drops of the metal which are intended to constitute the weld.

How the Gases Operate

In operation the two gases are carried from the steel bottles to the mixer where they are mixed as previously described for the cutting operation. From the mixer they are carried to the torch through a single tube and enter this where there is a sharp enlargement in its shape. This considerably diminishes the velocity of the gases, and from there they pass through a conical tube that is perfectly smooth on the inside. This tube gradually diminishes in size down to the nozzle, and the speed of the gases gradually increases again until the minimum speed required is obtained.

Sample of Welding

As a sample of some of the fine work which can be done by welding with the oxhydric process, Fig. 22 shows an art piece in which the leaves, petals, stems, and ribbon were worked out by a blacksmith with a hammer and anvil, and the whole was then welded together by welding the leaves and petals to the stem.

The American Oxhydric Company, Milwaukee, Wis., are preparing to make oxygen and hydrogen for the market, and they will be able to supply these gases in steel bottles to users of the oxhydric process, as well as the numerous devices shown herewith for the cutting of metals and other machines which will be added for special kinds of work.

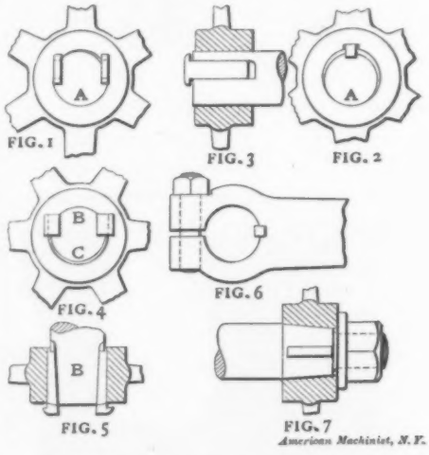
In British Pat. 6029 of 1908, the Company Bismarckhütte describes a method of improving steel produced in electric furnaces. The steel previously refined in a basic electric furnace is passed into a crucible with an acid lining and allowed to settle. A mechanical readjustment takes place, the steel taking up silicon, and a favorable influencing of the internal structure of the steel is claimed. In addition it permits the production of iron alloys in a controllable manner, or the addition of modifying agents. The latter is accomplished by passing the unalloyed steel into the crucible before adding the modifying constituents.

The Wrong Use of the Double Key

By John E. Sweet

I find in setting men to put in the double key, as shown in Fig. 1, they are pretty sure to taper the keys flatways and make the keyways to receive that kind of a key, which is dead wrong.

To illustrate the point, let us see what is the result when using the ordinary key with a loose fit, as shown in Fig. 2. The ordinary taper key draws the hole to a bearing at *A*, and there are but two points in contact; as a result alternate strains tend to work the hole at *A* back and forth on the shaft, and there is nothing but a sliding fit to resist it. If the fit of the hole on the shaft is a tight and easy fit, then to resist alternate strains there are two features to resist it: the friction due to the taper of the key, and the mechanical



DIAGRAMS ILLUSTRATING USE OF THE DOUBLE KEY

fit of the sides of the key. If the friction is sufficient to resist the twisting, then no strain comes on the sides of the key, but if the friction is insufficient, the sides of the key have to take the strain, and the sides have so little bearing it soon pounds the metal away and the job is no longer secure. Driving the key does not help it, except to give the job a new lease of life on the friction fit.

The double key (and I wish I knew to whom to give the credit for it) works, when properly constructed, on an entirely different principle. The keys should taper edgewise, as Fig. 3 illustrates.

Driving the keys draws the hole at *A*, Fig. 1, to a tight fit, the same as the single key, and further, the tendency for the thing to twist by alternate strains is resisted by the keys in the direction, that if the metal is worn away, driving the keys takes up the wear.

Whereas if the keys are tapered flatways they pinch the part *B*, Figs. 4 and 5, but may leave the hole loose at *C*, and the

action is to pivot on the two wedges and prove the worst sort of a job. The man is sure to taper both the keys, which doubles the ease by which they can work loose. The thing fails, and the man who invented the two-key system is liable to get the credit of being a fool.

There are conditions when the double keyway may not be best. A rock shaft, with a feather to locate its position with a grip fit, Fig. 6, is usually reliable; and for wheels, when they are subject to alternate strains, a feather to locate it, a taper fit forced on with a nut, Fig. 7, will answer all requirements.

The Grinding of Optical Lenses

By S. B. Redfield

The accurate grinding of irregularly curved surfaces, such as optical lenses, should be of timely interest in these days when the grinding wheel occupies so prominent a position in the manufacturing world.

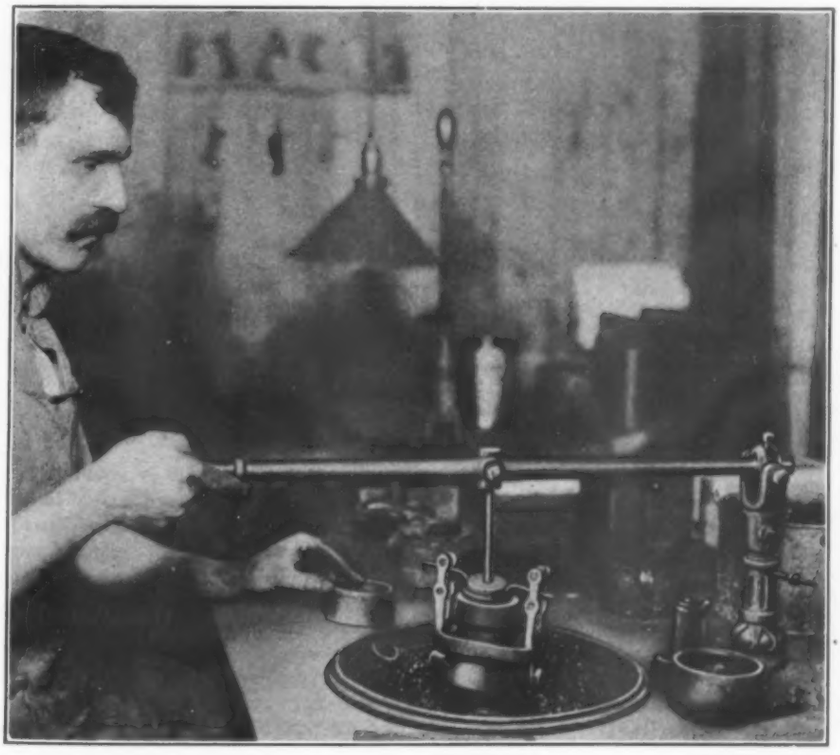


FIG. 1. GRINDING A COMPOUND CYLINDRICAL LENS. OPTICAL WORKS OF A. MARTIN, INC., NEW YORK CITY

Lenses, of course, take various forms, but the simplest form is that when the surface of the lens forms a part of a true sphere or spherical surface. Another form is known as the cylinder, and as its name implies, the surface of the lens then forms part of a cylindrical surface, having a curvature in one direction only. A third form of lens, and that the most interesting, is also termed a cylinder, but is composed really of a combination of two cylindrical surfaces. By this it is not meant that one side of the lens may have one curved surface and the other side another, but one single surface may be made up of a combination of two cylindrical surfaces on the same side, and the other side could just as well be perfectly plain.

The maximum radius of curvature of one of these compound cylindrical surfaces is unusually made at right angles to the minimum radius of curvature, and the radius of curvature at any other angle is, of course, some figure between these two, its actual value depending upon the position relative to the axes of the maximum and minimum radii of curvature. It is these compound cylindrical surfaces the grinding of which is of special interest.

Spectacle lenses are made of a particular quality of glass cast or pressed in molds and it is these pressed-glass pieces which are ground on special machines to give them the curvature required by the oculist's prescription.

Grinding Spherical Surfaces

The grinding of the true spherical surfaces is a very easy matter. The photograph, Fig. 1, shows one method of grinding spectacle lenses, and Fig. 2 illustrates the different kinds of tools or formers used in the grinding. The tools are

FIG. 2. TOOLS FOR GRINDING LENSES

A, concave spherical surface. *B*, convex spherical surface. *C*, compound-convex cylindrical surface.

mounted on a vertical spindle and made to revolve at high speed. The surface of the tool itself is the exact reverse of the surface which it is desired to grind upon the glass of the lens. The glass is fastened to a small iron block by means of pitch. The block has a depression in its center and into this depression a metal pivot attached to a lever is pressed to hold the block and the glass against the revolving tool. For spherical surfaces the yoke, shown in Fig. 1, is not required, as the block and glass are simply pressed against the tool by the lever and pivot. For the first rough grinding crushed steel is applied to the face of the tool, the grinding being done in the presence of water. After the rough grinding coarse emery is used, and this is followed up with fine emery, then with emery flour, which completes the grinding. The lens is then polished by a piece of rouge-covered felt placed on the top of the tool. This polishing makes the glass transparent.

Grinding Compound Surfaces

It is easy to see how by these tools a true spherical surface can be ground on the glass, but in order to grind one of the compound cylindrical surfaces a different procedure is necessary. In Fig. 2 the tool marked *C* is used for grinding a positive or convex-compound cylindrical surface, the surface of the tool, as said, being the exact reverse of that desired on the glass.

In order to more clearly understand just what one of these compound cylindrical surfaces is, we can imagine, first, a plain cylindrical surface. Now consider that this plain cylindrical surface is bent by some means so as to form a curve along the axis of the cylinder. An example of

this can be imagined by considering a small section cut out of, say a 2-inch diameter pipe at a point in the surface of the pipe where the latter is bent to a curve, say a 12-inch radius. This, it is seen, would form a surface having a different radius of curvature in two directions at right angles to each other; that is, in one direction the surface would have a radius of curvature equal to the radius of the outside of the 2-inch pipe, whereas at right angles to this the radius of curvature of the surface would be 12 inches plus the radius of the pipe itself.

In order to grind such a compound-curved surface the tool used, *C*, Fig. 2, is mounted on a vertical spindle and mounted with it so as to revolve with it there is the yoke with the two uprights, shown in Fig. 1. This yoke is hinged to the vertical spindle so that it will swing over the surface of the revolving tool, but must revolve with the tool at exactly the same speed. The piece of pressed glass which it is desired to grind is fastened onto a metal block by means of pitch, and this metal block is provided with a pair of arms which fit into the uprights on the revolving yoke. The block with the glass is free to move across the face of the tool parallel to the arms on the block by sliding through the uprights and as already explained, the uprights themselves are so hinged as to be able to swing in a direction at right angles to this. By these two combined movements at right angles to each other the block with the lens may be made to occupy any position on the surface of the revolving tool, but at the same time it must revolve on its own axis at exactly the same speed at which the tool revolves, although the axis of the tool and the axis of the block and lens need not coincide.

Now it is seen that if the lens is held by means of the lever and its pivot so that the axis of the tool does pass through the axis of the block and lens, and the tool and the lens revolve at the same speed there will be no relative motion between the tool and the lens and consequently there will ge no grinding. If, however, the lever is swung to one side by the operator so that the pivot and the axis of the lens are not in line with the axis of the revolving tool, although the lens will revolve at exactly the same speed as the tool, there will be a relative motion between the tool and the glass and by the application of the crushed steel or the emery, actual grinding of the glass will take place. Not only will grinding take place, but, although it seems as if the glass is allowed to slide all over the surface of the revolving tool, it is, nevertheless, a fact that the glass will be ground so as to conform exactly to the surface of the tool, even though this surface is compound as already described and has different radii of curvature in two directions. This is a little difficult to see, although it is true, and this is what lends interest to this form of grinding.

FIG. 3. CUTTING OUT THE ELLIPSE

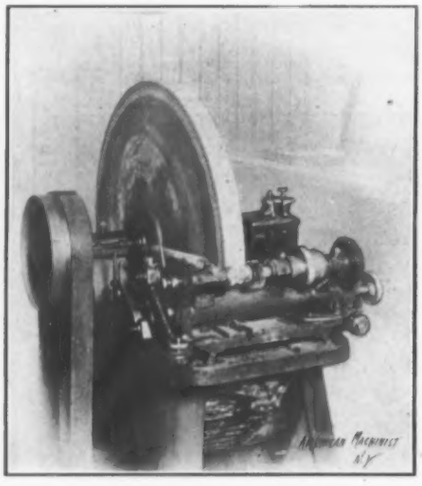


FIG. 4. AUTOMATIC ELLIPTICAL GRINDER

FIG. 5. DIAMOND POINTED DRILL FOR LENSES

Cutting and Drilling

The other photographs given show the various machines used in finishing up the lenses. There is also another instrument by which the actual position of axes of the maximum and minimum radii of curvature of a lens are located. This acts upon the principle that a straight line viewed through a cylindrical surface will be continuous with that part of the line seen outside of the surface only when the axis of the cylindrical surface and the straight line are parallel with each other and by rotating the line when the lens is held stationary the actual position of these axes is easily obtained. This is done to enable the operator to cut and mount the lens so that its axes may be at the correct angle as prescribed by the oculist. Fig. 3 is an instrument which marks out with a diamond point the elliptical shape of an ordinary spectacle lens, the eccentricity of the ellipse being variable. After this marking the edges of the lens are chipped off with ordinary pincers and then the lens is mounted on the machine shown in Fig. 4. This is an automatic machine which grinds the edges of the lens. By means of a small former the revolving arbor holding the lens is caused to approach and recede from the revolving stone so as to produce the true elliptical shape desired. The stone is also automatically traversed back and forth to prevent scoring of its surface. Fig. 5 is a small drill having a diamond point which drills the holes through the lenses for the mounting.

We are indebted to A. Martin, Inc., of New York City, for the information and photos here given.

A report on the causes of failures in business undertakings recently published by Bradstreets gives some interesting particulars from which it is noted that in the year 1908 there were 14,044 failures which is an increase of more than 35 per cent. over the previous year. Analyzing the causes of such failures it has been found that each thousand were accounted for as follows: Lack of capital, 342; incompetence, 216; disaster, etc., 189; fraud, 115; inexperience, 40; neglect, 22; faulty credits, 20; bankruptcy of others, 18; competition, 18; extravagance, 10; speculation, 10.

The weights of pile-driver hammers most favored by railroad engineers representing 37 roads and by 14 other engineers and contractors are 2500 and 3000 lb., as shown by data in the report of the committee on wooden bridges and trestles of the American Railway Engineering and Maintenance of Way Association. This refers to piledrivers for use on water, land and on railroad cars. Out of 57 replies to the question as to type of hammer, 43 preferred drop hammers.

Friction and Abrasion Tests on Steel Wedges

There Is No Change in Coefficient of Friction for Loads up to Elastic Limit. Abrasion Does Not Take Place until Elastic Limit Is Approached

BY J. S. MACGREGOR

Following is a report on friction and abrasion tests upon Hawk brand, hardened-steel wedges made at the Columbia University testing laboratory. The wedges were furnished by the United Shoe Machinery Company, of Beverly, Mass., to whom the results were of interest as applying to problems in machine design.*

It was through Prof. Ira H. Wooson, of Columbia University that arrangements for the tests were made, and the experiments were benefitted by his suggestions and aid.

The specimens submitted for tests were in the form of steel wedges having an approximate area of 25 square inches. These were in pairs and were made of hardened Hawk brand steel, with polished faces. Three sets were received, having faces cut at angles of 7, 10 and 15 degrees to the horizontal, respectively. Previous to making the tests we made some calculations regarding the probable effect of loading such inclined planes, and determined that the angle of repose of such polished steel was between seven and eight degrees. Having determined this and knowing that the magnitude of the frictional resistance, up to the point of abrasion, is directly proportional to the applied load, it follows that for any angle greater than the angle of repose there will

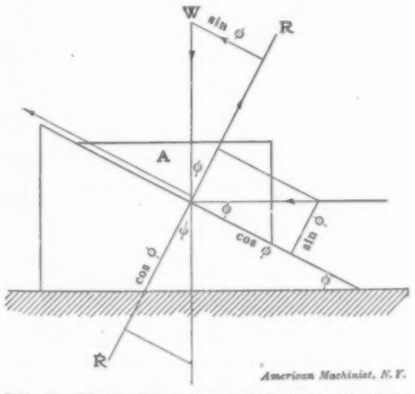


FIG. 1. DIAGRAM ACCOMPANYING COMPUTATIONS FOR HORIZONTAL THRUST OF A WEDGE

exist a condition of unstable equilibrium which, if not counteracted by some outside force, will cause the wedge to slip; for any angle less than the angle of repose, no matter what the load applied (within the working limits of the material) the wedge will remain at rest.

The wedges were tested in pairs in a 400,000-pound testing machine, using the holding device shown in Fig. 3. Readings were taken in increments of 25,000 pounds up to 400,000 pounds, that is, after each 25,000-pound load was applied the set screws were run back and the slip, if any, was noted.

In the case of both the 10- and 15-degree wedges, the wedge followed the set screw, as it was run back in each case up to the full capacity of the machine. Upon removal from the machine the faces of both sets of the wedges were in perfect condition. In the case of the 7-degree wedge there was no slipping at any time up to the machine's limit. These results appeared to confirm our calculations.

The effect of lubrication was next

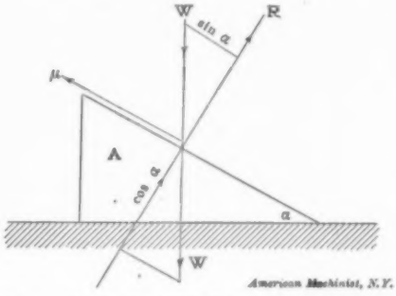


FIG. 2. DIAGRAM ACCOMPANYING COMPUTATIONS IN REGARD TO COEFFICIENT OF FRICTION AND ANGLE OF REPOSE

studied, using the 7-degree wedges. In the first instance, dry-flaked Dixon's graphite was used, and no slipping occurred up to 400,000 pounds. The graphite was then mixed with a good grade of machine oil and slipping occurred at any load through the 400,000-pound range.

The areas of the wedge surfaces of the specimens submitted were too large to permit the study of abrasion, for it is probable that abrasion will not take place until a load approaching the elastic limit of the material is reached.

Horizontal Thrust

The development of the formula for determination of horizontal thrust, as well as a problem showing its use, is herewith given:

To determine the force F necessary to keep the wedge A in stable equilibrium when acted upon by a load W. See Fig. 1. If the force F were not acting the resistance to motion of the wedge A would be controlled by a force equal to the coefficient of friction μ between the sliding surface multiplied by the normal component R of the load W.

This normal component is equal to $W \cos. \phi$ as indicated by the continuation of the forces R and W to form the lower triangle of the figure. If F is acting, it will be resolved into two components, one parallel to the inclined plane opposing

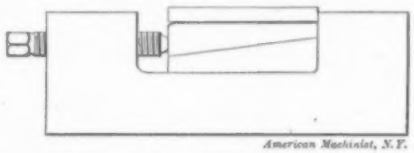


FIG. 3. HOLDER FOR THE WEDGES

motion, and the other acting normally to the plane. This latter acts in coöperation with the normal component of W and increases the friction by an amount $\mu F \sin. \phi$.

Therefore, we have the reaction of the force W, which is $\mu W \cos. \phi$ added to the reaction of the force F, which is $\mu F \sin. \phi$ added to the opposing component of F acting along the plane, which is $F \cos. \phi$ balancing $W \sin. \phi$, which is the component of W tending to push the wedge down the plane, or

$$F \cos. \phi + \mu W \cos. \phi + \mu F \sin. \phi = W \sin. \phi,$$

$$F (\cos. \phi + \mu \sin. \phi) + \mu W \cos. \phi = W \sin. \phi.$$

$$F = \frac{W \sin. \phi - \mu W \cos. \phi}{\cos. \phi + \mu \sin. \phi}$$

$$= \frac{W (\sin. \phi - \mu \cos. \phi)}{\cos. \phi + \mu \sin. \phi}. \quad (1)$$

But μ is equal to the tangent of the angle of repose as is apparent from the following demonstration (see Fig. 2):

$$W \sin. \alpha = W \mu \cos. \alpha$$

$$\therefore \mu = \frac{W \sin. \alpha}{W \cos. \alpha}.$$

The W cancels, and since

$$\frac{\sin. \alpha}{\cos. \alpha} = \tan. \alpha, \ \mu = \tan. \alpha.$$

Also, μ is equal to the coefficient of friction,

$$\therefore \tan. \alpha = \text{the coefficient of friction},$$

Now substituting in equation (1) $\tan. \alpha$ for μ we obtain

$$F = \frac{W (\sin. \phi - \tan. \alpha \times \cos. \phi)}{\cos. \phi + \tan. \alpha \times \sin. \phi}.$$

*[The AMERICAN MACHINIST aided in putting in communication the representative of the United Shoe Machinery Company, and the directors of the Columbia University testing laboratory, with the object of promoting these tests. Such coöperation is a pleasant duty and the editorial staff is always ready to aid, so far as may be proper, in reaching solutions of problems in machine design.—ED.]

As has previously been stated, the angle α was determined to be between 7 and 8 degrees.

The following example will show the application of the formula:

Determine the thrust of a wedge in the direction F, Fig. 1, due to a load W of 300,000 pounds when the angle ϕ is 15 degrees and the angle of repose is 8 degrees.

Solution:

$$F = \frac{W\,(sin.\,\phi - tan.\,\alpha \times cos.\,\phi)}{cos.\,\phi + tan.\,\alpha \times sin.\,\phi} =$$

$$\frac{300{,}000\,(0.25882 - 0.14054 \times 0.96593)}{0.96593 + 0.14054 \times 0.25882}$$

$$W = 300{,}000.$$
$$sin.\ \phi = 0.25882.$$
$$tan.\ \alpha = 0.14054.$$
$$cos.\ \phi = 0.96953.$$

= 36,500 pounds (slide-rule computations).

Tests to Determine Horizontal Thrust

Subsequent to submitting the above data the United Shoe Machinery Company requested that tests be made to determine the horizontal thrusts of the wedge directly.

The method of this determination was as follows:

Steel springs were taken from steam-engine indicators and used for low loads. These springs were carefully calibrated before use, so that the amount of compression in them for any load was known. They were then placed between the upper wedge and abutment and took the place of the set screws shown in Fig. 3.

For high ranges of loads short cylinders of copper were used in place of the springs. These were ½, ¾ and 1 inch in diameter and cut with extreme accuracy to a length of 1 inch. The ends were turned perfectly parallel; cold-rolled commercial stock copper was used for this purpose.

Since the angle between the faces of the wedges, the horizontal thrust and the direct load are known, the coefficient of friction is easily determined by substitution in the formula given.

Considerable difficulty was encountered in the use of the copper cylinders owing to the copper being rolled and possessing considerable elasticity and a fairly high elastic limit. This fact made it necessary to study the elasticity of the copper used; to determine its elastic limit and to note the effect of time upon its deformation under load.

Since it was necessary to remove the cylinders from the apparatus in order to measure the compression which took place due to the application of load to the wedges, it was found that results could be relied upon only in a range of compression past the elastic limit, because up to this point upon removal of load the cylinder regained its original length with the exception of a very slight permanent set; but after the elastic limit had been passed the metal was in a semi-plastic condition and would retain a definite deformation produced by any specific load.

For a certain range of loads beyond the elastic limit it was found that the deformation produced by the flow of the metal

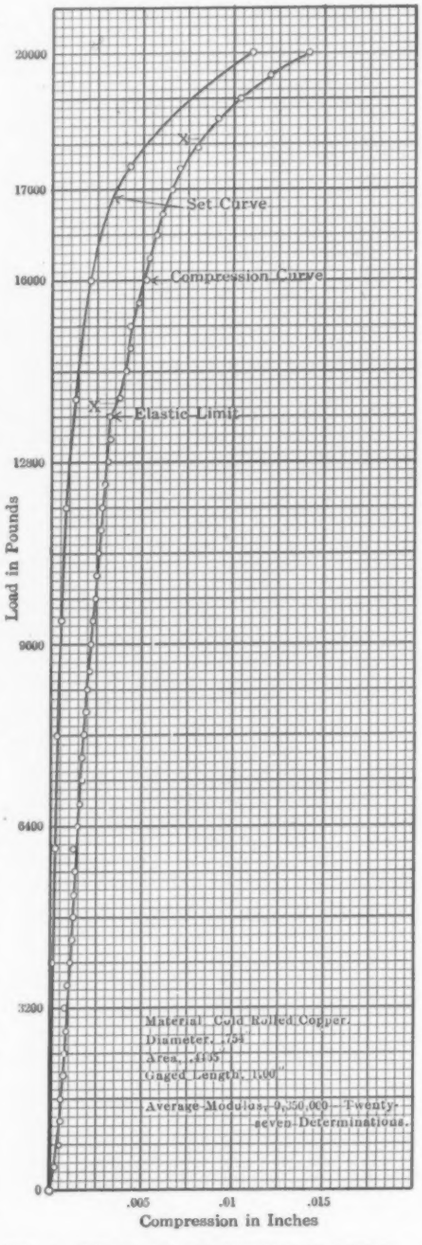


FIG. 4. STRESS-STRAIN DIAGRAM OF COPPER—COMPRESSION TESTS

under a given load was not appreciably increased by short time intervals, but beyond this range the metal would continue to flow under continued application of a given load to such an extent as to make readings of no value.

It will, therefore, be seen that the range of loads for which any particular cylinder could be used for this purpose was quite limited.

Referring to the stress-strain diagram the section of the curve between the letters X represents the range through which the ¾-inch cylinders could be used.

Another difficulty encountered in the case of the high loads, which was not unforeseen, was the restraining action of the head of the testing machine through which the load was applied. This restraining action reduced the value of the coefficient somewhat and is an unsurmountable source of error.

The average coefficient of friction obtained for the low range of loads (100 to 800 pounds) was equal to 0.14+, which corresponds to an angle of repose of 8 degrees. For this range of readings a very small machine was used and the set-up was such that the restraining action of the head was negligible.

The average coefficient of friction obtained for the high range of loads (90,000 to 220,000 pounds) was equal to 0.104, which corresponds to an angle of repose of about 6 degrees.

There is no reason to suppose that the true angle of repose was altered due to the application of higher loads. The apparent drop of 2 degrees was without doubt due to the restraining action of the head of the machine as already explained. This is further substantiated by the fact that this angle value is quite constant through the range of the high loads.

Following are a few values of the horizontal thrust of the wedge due to the loads as given:

Applied Load. Pounds.	Horizontal Thrust. Pounds.
100,000	18,000
115,000	19,400
125,000	20,000
20[illegible],000	32,000
220,000	35,500

In conducting the above tests enough readings were taken to make the results reported an average of a great many observations.

For example; the coefficient of friction for the low range of loads represents an average of readings taken in increments of 25 pounds from 0 to 800 pounds and this with two different springs selected after a series of trials as being best adapted to the purpose.

In the use of copper cylinders for high loads the compression of each size cylinder due to direct load taken in increments of 1000 pounds was determined, and cylinders cut from the same bars were then used to measure the horizontal thrust. Readings were taken in increments of 10,000 pounds from 25,000 to 325,000 pounds.

Eight of these cylinders were used and a full series of readings were made upon each.

The results here reported represent an average of all readings through the respective ranges selected as described in the use of the ¾-inch cylinders.

The conclusions arrived at from the whole investigation are:

First: The coefficient of friction of this grade of steel is equal to 0.14 + and consequently the angle of repose is 8 degrees.

Second: The restraining action of the head of the large testing machine introduces a source of error, but because of the fact that results obtained are quite constant there is reason to believe that there is no change in the true coefficient of the steel for these higher loads.

Third: There will be very little, if any, change in the coefficient up to loads approaching the elastic limit of the material.

Fourth: Abrasion will probably not take place until loads approaching the elastic limit of the steel are reached. Placing the elastic limit of this grade of steel at some 80,000 pounds per square inch in compression and having 25 square inches it would take some 2,000,000 pounds to produce abrasion in the wedges used.

Fifth: The proportionality of frictional resistance to applied load would hold true up to something near the value given above.

Modulus of Elasticity of Copper

The stress-strain diagram and modulus of elasticity of the copper used in the above experiments is attached as a matter of interest.

In determining the modulus of elasticity of the copper, readings were taken in increments of 400 pounds. It will be noted that the average of 27 determinations of the modulus is 9,350,000. These values were very regular as is indicated by the stress-strain diagram.

So far as we have been able to ascertain, values of modulii given in works on materials of construction and engineering handbooks vary from 9,000,000 to 16,000,000. In all probability the higher values were obtained from specimens that had received considerable mechanical work in their fabrication. It is known that mechanical treatment has a marked effect upon the elastic properties of copper. A bar of copper ¾ inch in diameter (the size of cylinder tested) would not receive in manufacture the same amount of mechanical work throughout its entire section as would be received by bars of smaller size, and this would influence the elastic determinations.

To those interested in alcohol—as a power producer—it may be news to learn from a series of experiments made by a French chemist that one ton of dry peat will yield 41 gallons of pure alcohol spirits. The cost of this method of production is reported to be about one-quarter that of potato spirits, for instance, so that our large supply of peat may lead to a cheap source of alcohol production. After the peat fiber is hydrated it is treated with sulphuric acid and is thus changed into a sort of sugar which when fermented by means of a special yeast yields alcohol.

Turning and Boring Cone Pulleys

Editorial Correspondence

The machining of cone pulleys is one of the shop problems that has many solutions, which vary greatly according to the conditions of the work and ideas of the man in charge. At the shop of the Rockford Drilling Machine Company, Rockford, Ill., Mr. Milne, the superintendent, has developed some interesting methods for doing this work, as can be seen from the illustrations which follow.

The cones are first bored in the special machine shown in Fig. 1, being centered

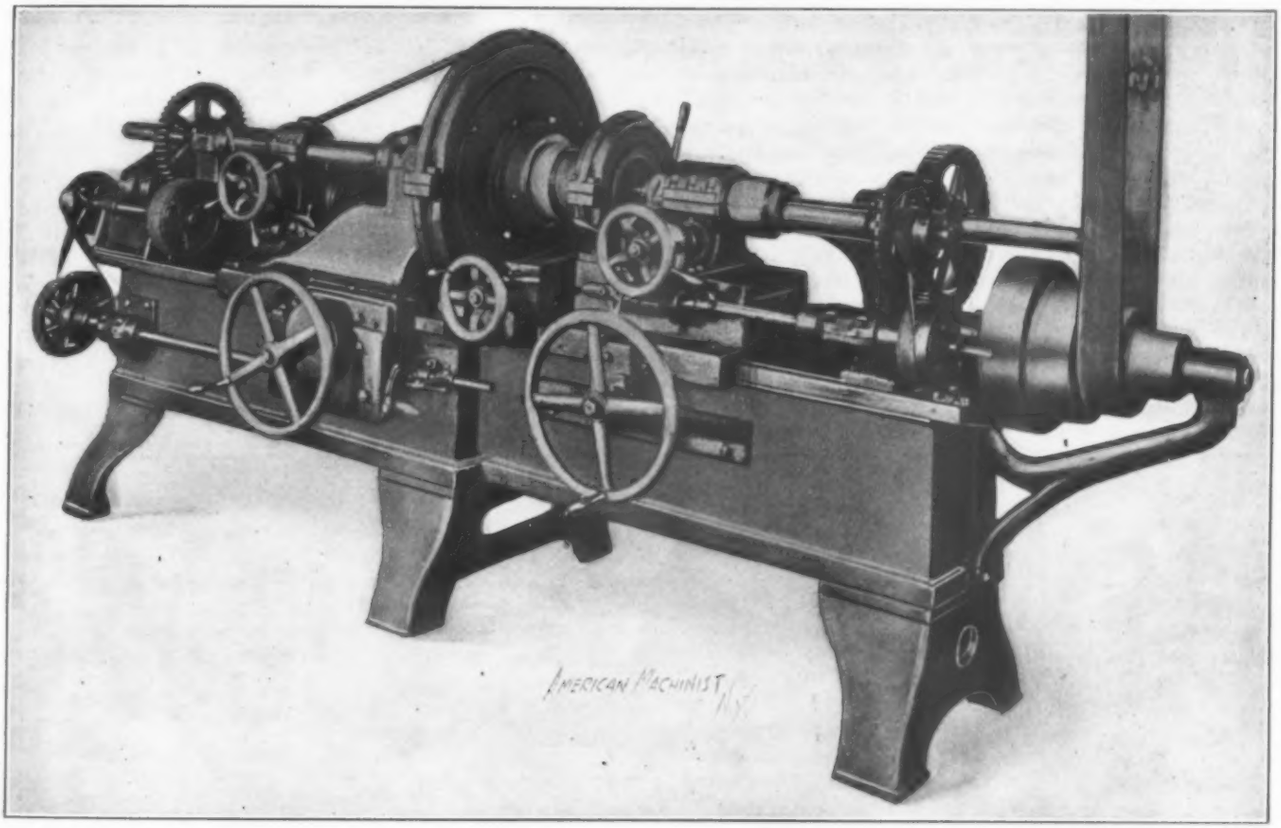


FIG. 1. BORING THE CONE PULLEYS

and held in a cone-shaped opening in the clutch of the large driving gear at the left. Set screws hold it from turning in the chuck. The small end of the cone is held in a similar arrangement at the right, centering it and supporting it firmly.

The cone is driven by the large gear surrounding it through a small pinion at the back of the machine, so that while it is firmly held and driven, both ends are free to be bored at the same time by the bars shown. These bars are driven from the same shaft as the cone gear, but the gears reverse the motion, so that they can easily be given the proper speed for economical boring.

The bars are fed by the chain coming

from the boring-bar shaft and then down through the belt and cones to the worm on the shaft. The details of this are practically the same as that of a drill-press spindle. The feed worm can easily be dropped out of the worm wheel for feeding by hand.

The boring bars have cutters made simply from square pieces of steel and consist of a roughing cutter and a finishing cutter which are followed by a reaming cutter, all being in the bar at the same time. The pulleys are also hand reamed after they come from the machine.

On the other side of the machine, not shown in the cut, is a carriage carrying three tools which feed in from the back and rough the side faces of the steps of the cone at the same time it is being bored.

In this way the cone pulley is bored at both ends and the side faces rough turned at one operation.

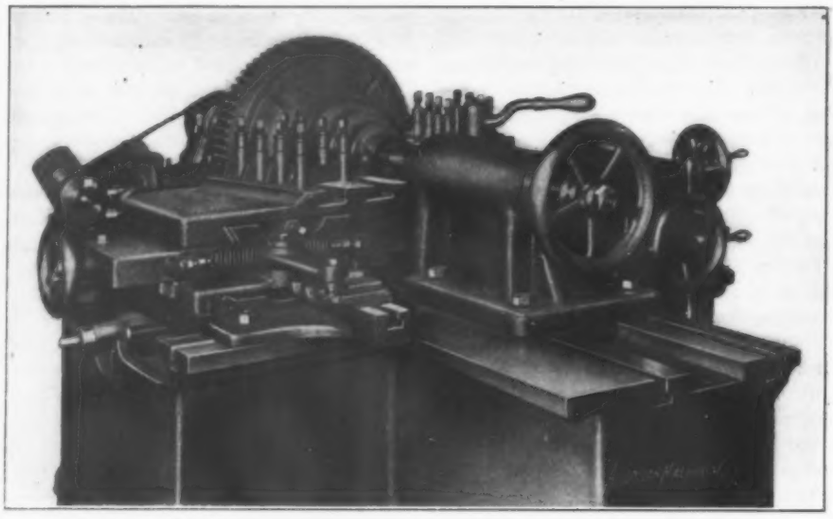


FIG. 3. THE CROWNING LATHE

Rough Turning

The rough turning is done on a very heavy lathe, as shown in Fig. 2. The special wing-tool fixture or box tool carries an arbor which centers the cone and on which it runs while being rough turned. The cone is driven by a driver with two studs, which is bolted to the face plate. This has a place turned on it between the studs and the face plate on which the yoke runs that is used to hold the two outer ends of the wing-tool fixture and prevent springing. In this way the tools are held very rigidly, and the cone must run centrally between them on the stationary arbor in the center.

Crowning the Cones

The crowning is done on another special lathe, shown in Fig. 3. There is a carriage on both sides, as can be seen, and each tool is held in two tool posts to insure rigidity. The whole tool block can be adjusted laterally, or in and out without affecting the power feed which moves the whole upper part of the carriage on the lower dovetails.

The power feed is very interesting, although not clearly shown, as the feed mechanism is beyond the carriage. It is derived from the worm wheel seen over the carriage and in front of the large driving gear. This worm wheel has a slotted face for obtaining different positions of the crank pin to secure the proper feed for different widths of face.

This crank movement is admirably

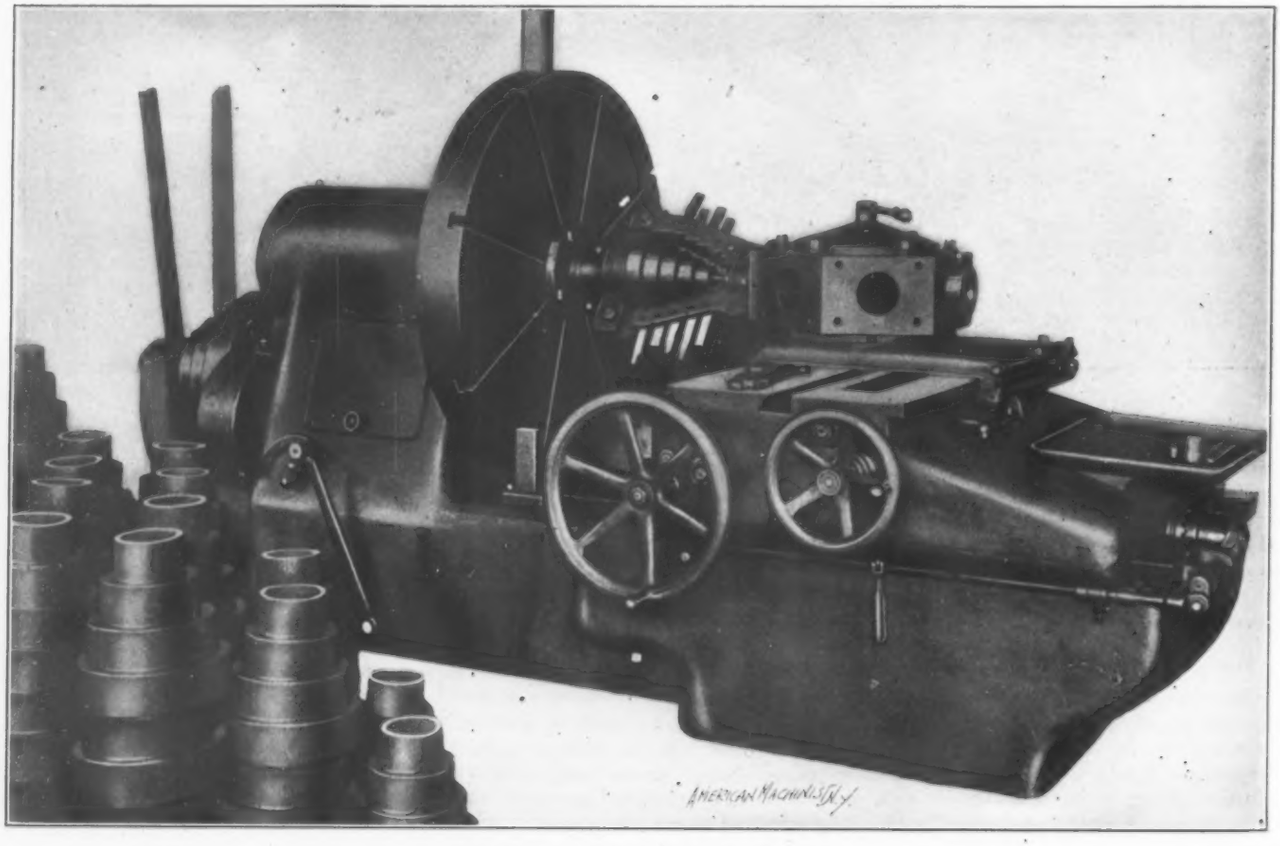


FIG. 2. TURNING THE FIVE STEPS AT ONCE

adapted for this feed on account of the slower movement at each end of the stroke and the positive length of the feed after being properly set.

The pulleys are rough turned with a straight face and the feed obtained from this crank motion gives a slow movement at the ends where the cut is heavy and a faster movement in the center of the crown, where there is little metal to remove. This is so adjusted that the tools undercut the sides of the steps a trifle at the end of the feed stroke, which makes it easier to polish.

The crowning movement is given by the former and lever at the nearest end of the carriage. The form is fastened to the T-slot of the carriage at the proper place and in this is the roller on the outer end of the arm. The other end is a segment of a gear which works in the rack on the side of the upper carriage, giving it the required in-and-out movement to produce the crown desired.

The preparations for this work are very complete and the equipment shown can handle a large number of pulleys, and large numbers are needed to keep up with the output of a modern drill-press business. F. H. C.

The Use and Calibrating of the Pyrometer

By C. U. Scott

Why is the pyrometer discarded in so many shops? What shall we use in calipering them? Under what conditions shall it be done?

As to the first question, I am thoroughly convinced that when it is discontinued it is because the shop is not properly equipped. In some instances, however, that have come under my observation I find that it is entirely due to the method of doing the work. For instance, as soon as a tool is finished it is sent to the hardening room on a *rush* order, and possibly, before it has reached the hardening room the toolmaker has been in to ask how soon it is possible to let him have the tool, and not spring it or lose it.

Then the superintendent drops around to ask if the tool has been hardened, and finally, when all have made their inquiries, the thermonipple is removed from the fire and the tool placed in the furnace to heat. The fire is then run up 300 degrees Fahrenheit higher than is wanted for the tool, as all the heat possible to generate in the furnace is used, and as soon as the tool has reached nearly the hardening heat, the fire is slowed up.

Of course, the hardener would not want the thermonipple connected during this time, for if the recording instrument was working the chart would look bad, and if anything happened to the tool in the hardening this chart might be looked up to see what was the matter. There are few who would want to look at the indicator on the pyrometer when taking not possibly the majority of heats, but a great many of them.

The pyrometer is absolutely of no value under such conditions. These conditions need not exist in any hardening department as the work of hardening tools must first be done with a view of safety. At no time should a hardener be requested to rush a tool whether it be an expensive or inexpensive one, as it can result only in injury to the steel. There is considerable difference between rushing the treatment of steel and rushing the man doing the work; as one only becomes tired while the other becomes worthless.

We might contradict the above statement in relation to heats by referring to the fused electrodes, barium chloride, or lead baths, but here the conditions are entirely different. In either of the above baths only the temperature desired can be generated while in a furnace the temperature can be raised way above that desired, no matter how cold the tool may be that is to be heated.

There is no reason why a tool slightly warmed should not be put into a furnace running at the desired heat for hardening, providing the furnace fits the work. This, however, is not the usual method pursued, consequently the pyrometer had just as well be left to rust.

I have seen an average of 5000 tools hardened per month by one man; he using two pyrometers to gage his heats: one for the higher heats and one for the lower. As the tools were brought to the hardening department they were separated into different bins according to size and carbon content. There were six bins, each with a card indicating the heat the tools were to receive. Then the furnaces were regulated to the proper heat.

An important part is to heat the large tools in the large furnace and the small tools in the small furnaces, as if the tools are too large for the furnace they will cool it down too much, and the time required for heating will be prolonged, thus causing brittleness. If the tools are too small for the furnace they will heat up too quickly on the thin parts, and the heat will rise beyond that desired. Good judgment, therefore, is required, even though pyrometers be used.

If each furnace is equipped with a pyrometer, the rise and fall of temperatures can be easily detected, but it is not absolutely necessary to have one for each furnace, although it is more convenient and more accurate.

Some say it requires so much time to use the pyrometer they cannot get out their work. I am thoroughly convinced, however, that should they be willing to wait for their work from the hardening department the tools would last longer, therefore, make less work in the tool room, and thus effect a saving that would more than pay for the pyrometers and the time consumed in using them.

There are many tools that could be rushed out and possibly give fair service, but if we are going to reap the benefits possible to obtain from the pyrometer, the hardening department should be given time enough to do the work right. This does not always mean that more time will be required for hardening tools, as it is possible to produce as much work with the pyrometer as without it, and the pyrometer is as necessary to the hardener as the micrometer to the toolmaker.

I have made tests in a lead bath, that held 120 pounds of lead and was heated to 1400 degrees Fahrenheit by placing a piece of steel in the bath, that weighed 12 ounces. This reduced the heat 12 degrees and it required three minutes for the heat to return to 1400 degrees. I have also taken the thermonipple and placed it in a gas fire for carbon steel just after starting it and in a few minutes it would register 1475 degrees Fahrenheit. I then placed the fire end in the forge fire, running the fire as it is originally run to heat a lathe tool of carbon steel and found the heat to be 1950 degrees Fahrenheit. By forcing the fire to what might be termed reasonable on a rush job, I found that the heat ran up to 2100 degrees Fahrenheit.

Great care should be taken in heating tool steel in the forge fire. The fire should, at no time, be hotter than the heat desired for the tool, as it would mean overheating of the outer edges, or the very part of the tool that is to do the cutting. It is my opinion that in heating a diamond-point lathe tool, in the forge fire, it should require at least seven minutes. If the tool is heated to the hardening heat back of the neck it should require at least 15 minutes. A fire not generating more heat than is wanted will not heat a tool quicker than the above, and to heat a bar $\frac{5}{8}$x1$\frac{1}{2}$ inches in three minutes, which is called slow by some, will not give the best results.

We can easily see where it is possible to get too much heat with a forge fire, but we are not able to observe the change so quickly in furnaces, although the change is there and takes place in nearly the same time. Thus, unless we give steel the proper time in the heating we will have no more use for the pyrometer than when using a forge fire.

There is one thing that we need and that is, some reliable material to calibrate pyrometers with. It seems to me that the metallurgical engineer should adopt some material and method for a standard. I have used sodium chloride melting at 1422 degrees Fahrenheit, sodium carbonate melting at 1498 degrees Fahrenheit and copper melting at 1980 degrees Fahrenheit, but may not have used them right. What I want to emphasize is: Should the test be made in an open furnace or a graphite crucible? Shall we use a speci-

fied number of grains? Can we use the same material more than once? When shall we make the reading for calibrating? When a part of the material is melted, or when the last particle of a limited amount is melted, or shall the reading be made as the material solidifies or congeals?

Nearly every material that I have tested shows a wonderful tendency to hold heat at the solidifying temperature; therefore, this seems to be the broader reading point. Small quantities do not lose any heat for from one to two minutes after being on a cautious drop for several minutes.

One metallurgical engineer found two shops that were using the same steel, one of which was heating it to 1300 degrees Fahrenheit, while the other was heating to 1690 degrees Fahrenheit, measured by pyrometers and both were having excellen results with their steel. In his judgment, however, both shops were heating to 1500 degrees Fahrenheit.

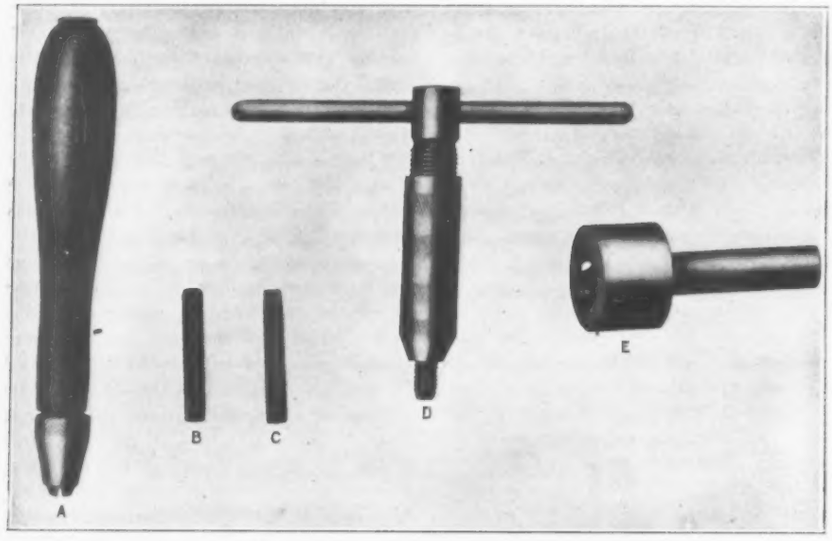
If we could have a standard material for calibrating pyrometers with full information on how and under what conditions to use it, we would reap some benefit from the information furnished by the American Vanadium Company, the mechanical journals and some of the steel companies. As it is, we will have to depend on the trained eye to establish all heats even though the pyrometer be used.

I have had the privilege of inspecting several pyrometers, other than the ones we use, and if I am to rely on my judgment, they were reading the same heats 180 degrees Fahrenheit lower than we were. It seems to me that when information is given out without a word as to the conditions under which the calibrating is to be done it will not be of sufficient reliability to warrant following strictly. In other words we will have to rely upon the judgment of the skilled man, whereas if we have a starting point we can hope to profit at once by such information.

The First Split Round Die—A Shankless Tap and the First 4-jawed Tapwrench

By E. A. Dixie

One always associates certain manufactures with certain names, of course, "There's a reason;" advertising is responsible for it. I went into a machinists' supply house the other day to buy a 7/16x22 tap. I did not exactly expect to get it because I knew it was irregular, although that would be no conclusive reason for it is remarkable what a lot of irregular stuff one is liable to get at times when buying regular goods. For instance, an order of ½-inch hex-head cap screws may contain cap screws with half a dozen different sizes of heads and more than likely both the 12- and the 13-to-the-inch threads will be represented in the lot.



THE FIRST SPLIT TAP WRENCH—SHANKLESS TAPS—A DIE HOLDER

The salesman didn't have the tap but said he, "Mr. Elterich around the corner can make it for you."

Now I did not associate the name with taps, for the reason given in the first paragraph and I told the salesman so, but when he added; "Mr. Elterich is the man who made the first split round die," it decided me that I wanted to see Mr. Elterich anyhow, whether he made the tap for me or not.

Charles Elterich is now a man over seventy, but he is in the shop at 177 Grand street New York and working every day. In 1871 he was toolmaker with the Western Union and it was while there that he made the first round split die which is so familiar to all machinists. *E* shows the holder he made for this die in 1871. *A* shows the first adjustable tap wrench which he made and patented in 1877.

B and *C* are shankless taps which he invented and which he says are the best and strongest taps ever made. Unfortunately there is little sale for these taps as customers will not pay the same price for what they call "half a tap" as they do for a whole one i.e., one with a shank. One feature of this tap is that it is double ended, one end tapered and the other either plug or bottoming as desired. In use it is gripped in the four jawed adjustable tap wrench *D* and is allowed to project the desired amount from the end of the wrench which can be made to act as a gage for tapping to depth. In this way the tap is supported near where it is doing the work and not at the end of a more or less flexible shank.

Mr. Elterich told me he has over 100,000 master taps, the accumulation of the years he has been making taps and dies. When he first started in business, if a customer ordered a special die he would charge for the special tap at cost. The customers regarded this as an imposition as they had ordered a die and not the tap which was charged for and thrust upon them. Another bad feature from the diemakers' point of view was that the customer with the special tap in his possession could make his own dies. So eventually special dies were charged for at a slight advance over regular goods, the master taps were kept and the dies could be duplicated at any time. Mr. Elterich has customers using special dies for whom he has duplicated dies made by him twenty or more years ago.

In 1896 Mr. Elterich invented a new form of tap and in 1897 a new form of die to go with it. These taps and dies were fully described in the American Machinist, Vol. 20, page 759. These dies and taps enable one to cut male and female threads which are practically identical. I saw a ¾-inch nut 11½ inches long cut with one of these taps and a plug for it threaded with a die. These fitted each other without shake and the plug could be entered from either end.

I also saw a 2-inch pipe fitting and nipple threaded by these patented taps and dies and screwed together dry, that is, without any oil, red lead or other jointing material. These stood a pressure of 1200 pounds per square inch without a weep. So I am glad I went around to see the man who made the first split die. In these days of standard sizes and threads which are not standard it's a comfort to know a man who has 100,000 different sizes and pitches of master taps, for one of them may be just right for that next repair job with its *almost* standard threads.

Relation of Cutting Speed, Feed, Depth of Cut

Presentation of Herbert's Cube Law—Cutting Speed Varies Inversely as the Cube Root of the Product of the Feed by the Area of Cut

BY EDWARD G. HERBERT*

In a recent article I gave a description of the Herbert tool-steel testing machine, and discussed the results of a number of experiments that have been made on it. In this machine, it will be remembered, tests of cutting tools are made on a revolving tube of especially tough steel, the cutting being entirely on a miniature scale, usually making a chip 1/16 inch wide and about 0.001 inch thick.

Although the main object of the tests was that of showing the comparative durability of various steels, and their comparative capacity for working at high cutting speeds, yet it became evident that the value of the results would be considerably enhanced if it were possible to formulate a general law governing the relation between cutting speed, feed and depth of cut, whereby the data obtained under the abnormal conditions of the tests could be converted into terms of the very different conditions of practical work. Hence I was led to investigate the theory of wear in cutting tools, on lines which may have some degree of novelty.

In the article referred to, there were set forth certain reasons for the view that in most metal-cutting operations, the durability of the tool depends mainly on the temperature to which its extreme edge is raised, owing to the evolution of heat in separating the metal. Several such reasons are:

(1) Although the wear-resisting properties of a tool might have been expected to depend mainly on its hardness, yet it is found in practice that high-speed steel, which is not remarkably hard, will resist wear much better than carbon steel, which is much harder, especially under cuts heavy enough to generate considerable heat.

(2) High-speed steel does not keep an edge well under light cuts at slow speeds. It has long been known that durability can be increased by increasing the cut. It has now been shown by means of the tool-steel testing machine, that increasing the speed has the same effect on the durability as increasing the cut. A certain rate of heat production seems to be essential to give durability to the tool, and it is immaterial whether the heat is produced by high speed or heavy cut, or by such a combination of the two as will give the required rate of heat production.

(3) Although a certain rate of heat production is essential, too great a rate of heat production is destructive. It has been well shown by Mr. Taylor, that tools will work under conditions which, taken alone, would produce a destructive amount of heat, provided a jet of water is directed on the chip so as to carry off the excess of heat.

(4) The "speed curve" produced with the aid of the tool-steel testing machine, in which durability of the cutting tool is plotted against cutting speeds, is of the same general form as the curves produced by Mr. Shore, in which strength of steel is plotted against temperatures at which the steel was tempered, and the similarity even extends to the curious "dimple" corresponding to a brown temper in Mr. Shore's experiments. This suggests a close conection between the working temperature of the tool and its strength, as measured by durability.

Assuming then, that the durability of a cutting tool depends so largely on the working temperature and, therefore, on the rate of heat evolution, that all other conditions affecting its durability are comparatively unimportant and may be ignored without serious error, it follows: That the durability will be the same for any combustion of feed, cut and speed which gives the same rate of heat production; and this being so, it is only necessary to find the relation between feed, cut and speed with reference to heat production in order to established the relation betwen these three factors with reference to durability of the cutting tool.

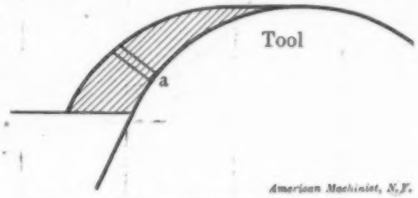


FIG. 1. DIAGRAM OF CROSS-SECTION OF A CHIP AND TOOL

Analogy Between a Jet of Water and Metal Forming Into a Chip

If a jet of water is directed from a hose against a wall, the energy of motion possessed by the water is dissipated in the form of heat, and the amount of heat so generated in unit time is proportional to the sectional area of the jet multiplied by the cube of the velocity with which it strikes the wall. The proof of this may be found in any treatise on dynamics.

Now we may regard that portion of a forging which is on the point of being cut away by a turning tool in the lathe, as a jet or stream of steel impinging on the point of the tool and dissipating its energy in the form of heat; and we may suppose that in this case also, the amount of heat generated in unit time will be proportional to the thickness or sectional area of the chip multiplied by the cube of the cutting speed. In order to understand exactly what takes place let us suppose that Fig. 1 represents the cross-section of a chip which is being taken off by a cutting tool and let us examine what happens to a very narrow portion a of the cutting edge. This small portion of the cutting edge has to deal with the narrow section of the chip which lies directly in front of it, which impinges on it, and which generates an amount of heat proportional to the cube of the cutting speed multiplied by the sectional area of this portion of the chip. But the area of this narrow section of the chip is equal to the width a of the part of the cutting edge under consideration (which is constant) multiplied by the thickness of the chip (undistorted).

So far, then, we may say that the rate of heat evolution on this part of the cutting edge is proportional to the cube of the cutting speed multiplied by the thickness of the chip. But this is not all. Heat is also being generated in all the adjacent parts of the chip which lie outside the narrow section to which we have hitherto confined our attention, and this additional amount of heat will be communicated by conduction to our narrow portion of the cutting edge, and will raise its temperature. It is clear, then, that the temperature of the small part a of the cutting edge will depend, first, on the amount of heat x generated in the portion of the chip which impinges directly on it (which we have found to be proportional to the cube of the cutting speed multiplied by the thickness of the chip), and second, on the amount of heat X generated in the remainder of the chip, and evidently the amount of heat X will be proportional to the sectional area of the whole chip.

We arrive, then, at this conclusion, that so long as the total area of the chip is unaltered, the heating of the cutting edge is directly proportional to the thickness of the chip multiplied by the cube of the cutting speed. If, on the other hand, the thickness of the chip remains unaltered, the heating of the cutting edge will be directly proportional to the area of the chip (and, therefore, to the depth of the cut) multiplied by the cube of the cutting speed. And if both the thickness

*Director, Edward G. Herbert, Ltd., Manchester, Eng.

of the chip and the area of the chip are varied, the heating of the cutting edge will be proportional to the thickness of the chip multiplied by the area of the chip, multiplied by the cube of the cutting speed.

Mathematical Expression of the Law —The Cube Law

We may now proceed to express the relation by means of a formula, and since the maximum thickness of the chip is *generally* proportional to the feed or traverse, we will call

t = Traverse,
c = Depth of cut,
a = Area of the cut, and
s = Cutting speed.

From what has been said above it follows that if t_1, c_1, a_1, s_1 represent the values of these factors for any given working conditions, and t_2, c_2, a_2 s_2 represent their value for another set of working conditions, then the heating of the cutting edge and, by assumption, the durability of the tool will remain unaltered so long as the relation

$$t_1 a_1 s_1^3 = t_2 a_2 s_2^3$$

holds good. From which it follows that for constant durability of the cutting tool

$$s_2 = s_1 \sqrt[3]{\frac{t a_1}{t_2 a_2}};$$

or, since $a = t c$,

$$s_2 = s_1 \sqrt[3]{\frac{t \cdot c_1}{t_2 \cdot c_2}}.$$

The cube law may be most conveniently stated thus:

The cutting speed varies inversely as the cube root of the product of traverse by area of cut; or alternatively, *the cutting speed varies inversely as the cube root of the product of depth of cut by traverse squared.*

So far we have been dealing exclusively with theory, but fortunately we are able to test our conclusions by the results of two carefully executed series of experiments; those made by F. W. Taylor and described in his address before the American Society of Mechanical Engineers, and those made at the Manchester School of Technology by a committee of the Manchester Association of Engineers.

F. W. Taylor's Experiments

Mr. Taylor's results are represented by the full lines in Fig. 2. In preparing this chart the speeds given in Mr. Taylor's table (No. 129) have been plotted against the corresponding cut areas (feed × depth of cut).

In order to test the formula let us take the point *A* as the basis of calculation, and find what should be the effect of increasing the area of the cut while keeping the feed constant at 3/16 inch according to the cube law. The result is shown by the dotted line, which evidently agrees closely with Mr. Taylor's results. This dotted line was obtained by assuming the speed to vary inversely as the cube root of the area of cut (feed remaining constant). Now taking *A* once more as the starting point, calculate what speed should be required for the *same area of cut,* when the feed is reduced from 3/16 to ⅛ inch. In this case the speed should vary inversely as the feed, since the area of the cut is constant. The result of the calculation is point *B*. Applying the cube law once more for constant feed and varying area of cut we obtain the dotted line passing through *B*, which lies right through the middle of Mr. Taylor's plotted observations.

Starting once more from *A* to find the speed for the same area of cut when the feed is reduced from 3/16 to 1/16 inch, we obtain the point *C*, and the calculated curve through this point is x^1, which does not agree as closely with Mr. Taylor's results. The reason is not far to seek. This series of experiments was made with a round-nosed tool, taking 1/16-inch feed with a depth of cut ranging from 1/16 to ½ inch, and obviously the thickness of the chip must have varied considerably as the depth of the cut was increased. In order to test this, Mr. Taylor's ⅞-inch tool was drawn out to a large scale and the actual thickness of the chip was found graphically for each depth of cut, with a feed of 1/16 inch. The maximum thickness of chip for each depth of cut was as follows:

Depth of cut $\frac{1}{16}$ inch, thickness of chip 0.037
Depth of cut ⅛ inch, thickness of chip 0.0525
Depth of cut $\frac{3}{16}$ and over, " of chip 0.0575

Applying the cube law

$$s_2 = s_1 \sqrt[3]{\frac{t_1 a_1}{t_2 a_2}}$$

and taking t to represent the thickness of chip given above, we obtain the curve x_2 which again lies right in the middle of Mr. Taylor's plotted observations.

The Manchester Experiments

We now turn to the Manchester experiments the results of which are given in Fig. 3. In this case three different qualities of steel were experimented on and, of course, it is not possible to pass from one curve to another by calculation. We, therefore, take a point on each curve, *D*, *E* and *F* as the bases of calculation, and the result is given by the dotted curves.

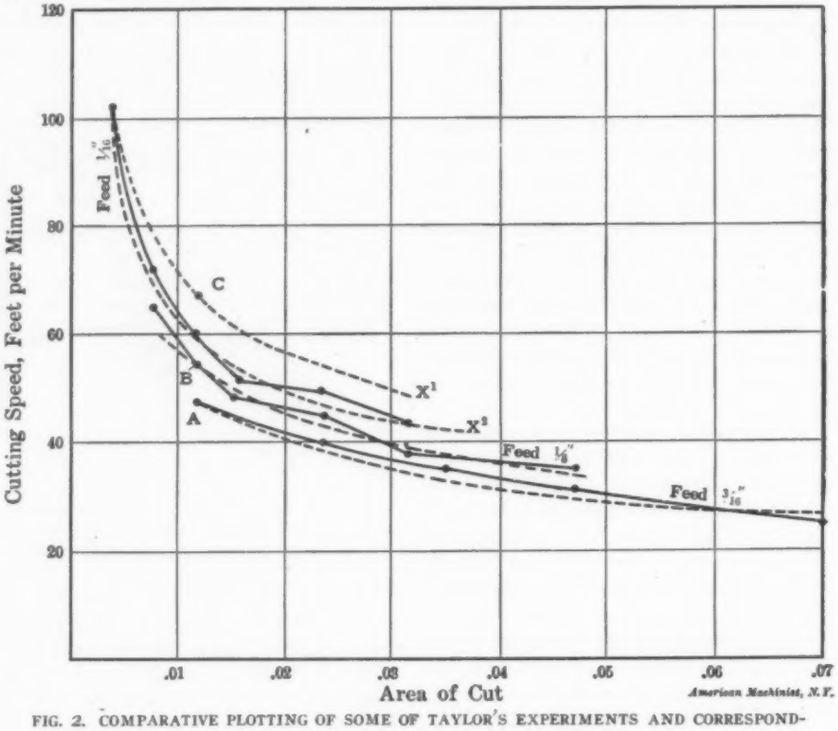


FIG. 2. COMPARATIVE PLOTTING OF SOME OF TAYLOR'S EXPERIMENTS AND CORRESPONDING QUANTITIES DETERMINED BY THE CUBE LAW

In these experiments both the feed and the depth of cut were varied simultaneously, and it was necessary to take into account both the feed and the area of cut in applying the cube law.

The general correspondence of the curves is sufficiently striking, but it appears that as the weight of the cut was increased, the observed speeds were in every case a little higher than those obtained by calculation. This seems to indicate a loss of heat. The cube law takes account of all the heat generated by the impinging of the chip on the tool, but as the cost becomes heavier, an increasing proportion of this heat escapes (probably in the chip) without affecting the temperature of the tool; therefore, the tool can be run at rather higher speeds.

As the weight of the cut is still further increased, the curves of theory and of

practice approach one another, and from their direction it might be expected that they would eventually cross one another. This actually takes place in the lowest curves in Fig. 2. This seems to indicate the coming into play of some new factor, or some factor assuming greater importance, and we may conjecture that this factor is the crumpling up, or telescoping of the chip, which would naturally generate an increasing amount of heat as the chip became thicker and, therefore, less able to bend back over the tool without rupture.

The correspondence between the curves of the cube law and of actual experiment is so close, as to leave no doubt that this law is not merely an empirical formula for calculating cutting speeds, but the fundamental law governing the relation between feed, cut and speed.

It has been shown that this law can be used to calculate from the observed speed for a light cut 1/16x1/16 inch to the corresponding speed for a cut 18 times as heavy, 3/16x3/8 inch, and that the results of the calculation agree almost exactly with those obtained by experiment. There seems, therefore, no reason to doubt that it can be applied to calculate through a still greater range, from the minute cuts used on the tool-steel testing machine to the heavier cuts used in workshop practice.

Three Important Factors

In order to apply the cube law to such calculations it will be necessary to determine and take account of three factors which have an important influence on the heating of the tool and, therefore, on the cutting speed.

(a) The quality of metal being cut. Mr. Taylor has graded many different qualities of steel with reference to cutting speed, but his list does not contain any steel approaching in hardness and toughness that used for the test tubes.

(b) The cutting angle of the tool. The standard tests on the tool-steel testing machine are made with a tool whose front cutting face is a plane surface, set exactly at right angles to the direction of motion of the surface being cut. It corresponds to a turning tool without rake or side slope, and set level with the center of the job. Such a tool is very inefficient. It generates a large amount of heat and requires much slower speeds than a tool correctly ground for rapid cutting.

(c) The tests on the tool-steel testing machine are all made under a copious flow of water. This is necessary because the thin test tube would otherwise be raised to such a temperature as to alter its physical properties. The speeds appropriate for cutting under water are considerably higher than those which could be used in cutting dry. Mr. Taylor has already published data to show how the cutting speed is affected by a stream of water directed on the chip. The factors a and b can be readily determined by experiments with tool-steel testing machine.

Reconciling the Manchester and F. W. Taylor Experiments

The discovery of the cube law has one result of rather special interest. It reconciles the apparent discrepancies between the results of Mr. Taylor's experiments and those made in Manchester, and in so doing it settles the vexed question of the relative importance of thickness of chip, depth of cut, and area of cut, as regards their influence on the cutting speed.

If the two sets of curves in Figs. 2 and 3 are plotted on the same chart, they are seen to lie at different inclinations, the two sets of curves tending to cross each other. This is now seen to be due to the fact that Mr. Taylor increased the area

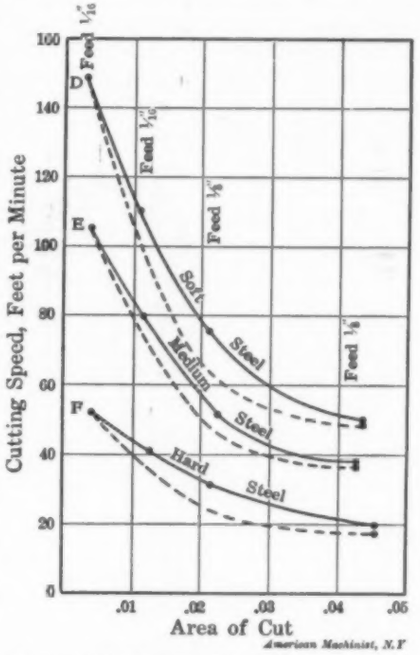


FIG. 3. COMPARATIVE PLOTTING OF SOME OF THE MANCHESTER EXPERIMENTS AND CORRESPONDING QUANTITIES DETERMINED BY THE CUBE LAW

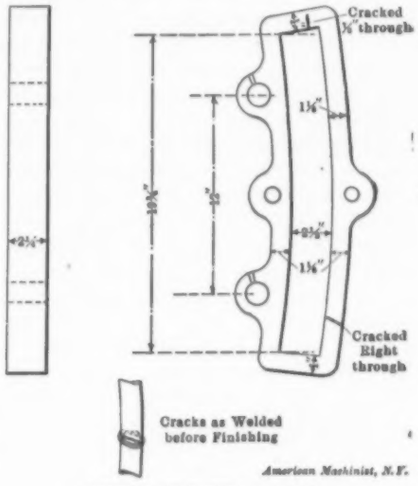
of his cut by increasing its depth only, while keeping the feed constant. In the Manchester experiments both feed and depth of cut were increased simultaneously. The assumption of the Manchester committee, that cutting speed is dependent only on area of cut and is independent of the ratio between cut and traverse, is seen to be incorrect. On the other hand it appears that the formulas elaborated by Mr. Taylor to give mathematical expression to his result, are capable of great simplification, and his tables calculated on the assumption that speed varies inversely as the square of the feed, require modification.

In cutting cast iron, the cube law as stated above is only applicable in the case of coarse feeds. When the feed is less than 1/16 inch the thickness of the chip has very little influence on the speed, which varies inversely as the cube root of the area of cut approximately.

Fusion Welding a Link

By William Fowler

The accompanying line cut shows a job we recently did which was rather unusual. It was welding a link by the oxy-acetylene process that was broken in two places. The link was from a Standard locomotive and was cracked as shown. The cracks we



FUSION WELDING A LINK

welded to the center from all round, using swedish iron with a flux. After the welding we case-hardened the link, it being in the furnace 10 hours. When it came out it was distorted from 1/32 to 1/8 inch. After springing it back to shape and polishing it, no sign of the fracture showed anywhere, and the welded parts looked as well as the rest of the link. The link was wrought iron and welding it saved making a new one.

According to the United States Geological Survey, the number of buildings erected in the United States in 1908 was 163,087, which cost $546,467,390.

The high price of platinum, which is commercially used in many instruments and utensils where it is necessary to withstand very high temperatures, has fostered experiments to discover a suitable substitute for it in this respect, and many have from time to time been announced. A recent report has gained cognizance that a German chemist has produced a new chemical substance which is to be called silundum which, it is claimed, can be utilized in melting furnaces, electric radiators, and the many other instruments employing great heat in their work. The substance is produced by heating carbon in the vapor of silicon at a temperature of something like 3000 degrees Fahrenheit, and in the event of the substance proving to be what is claimed for it there will be a wide variety of uses to which it can be put.

The Analysis of Steel by Mechanical Means

Carbon in Tool and Mild Steels Can Now Be Determined in a Few Minutes in the Shop, also Phosphorus, Manganese and Tungsten

BY A. F. SHORE*

In my last article on page 222, of which this is supplementary, some reference was made to the phenomenon of crystallization, which also shows a loss of hardness by the scleroscope test, and which is then taken as a symbol of the carbon contents in tool steel owing to the greater and greater loss of hardness after overheating, as the carbon content is higher.

Something like three months have elapsed since these "startling disclosures," as they have been referred to, were made, giving ample time for criticisms and comments, which have been received from all parts of the world, and which are of great interest, particularly because we learn something about the prevailing theories covering the subject. Replies have come in which were prepared by men high in the profession and who have quoted authorities to the effect that, when a very high-carbon steel is overheated it gets very much harder, instead of softer, as the scleroscope shows it, and requesting an explanation which is really nothing more or less than the fundamental principle of the new science of toolmaking, and which has once more brought ordinary carbon steel into the foreground.

Crystallization

The general theory that the hotter you heat a piece of tool steel the harder it gets, is, presumably, due to the fact that the prevailing opinion as to what hardness really is is not altogether correct.

The belief that a high hardness must be accompanied by a crumbling up or brittleness is particularly wrong in dealing with metals, although it may not be so much out of place in minerals, for some of these will easily scratch the hardest steel, while yet extremely brittle as a mass, and have an insignificant tensile strength or ductility.

High-carbon steel, when so much overheated as to crystallize very much, is very different from the same when treated at just the right heat. In the former instance the metal, when fractured, shows coarse crystals, as a mineral would and like it can be crushed quite easily, while in the latter the fracture is different, as are also the physical properties.

While it is true that a crystallized steel may have particles quite as hard as one in the good condition, which is hard as a body, it is clearly obvious that such a form of hardness is of no value whatever to the arts. The kind of hardness which is at the bottom of fine tools is one which combines also a vast amount of strength; the more strength the more effective will the hardness be.

What the Scleroscope Measures

The scleroscope does not measure hardness in a fantastic, scientific way, so as to make us wonder just what it does measure, but it simply crushes the surface of the sample with a force of over 500,000 pounds per square inch. This force is great enough to overcome the elastic limit of the hardest and finest steel.

An annealed diamond is used in the hammer and under it no steel is too hard to actually flow, or be penetrated more or less. In steels properly hardened there is very little penetration and therefore a great reaction for the indicator hammer, thus showing great hardness and edge-holding power. When the same steel is crystallized so slightly that it cannot be detected by the fracture, the reaction of the scleroscope indicator is at once less, owing to its penetrating deeper into the steel.

Effect of the Carbon in Crystallized Steel

If the carbon content is a low one (0.90 to 1 per cent.) there will be a noticeable drop in the hardness, following the slightest overheating, although once thus weakened there is no further drop in hardness after applying more heat, even up to 1800 degrees Fahrenheit. As now the carbon content increases gradually up to 1.70 per cent.—the highest thus tried out—there will be a corresponding crystallization and this increases more and more in proportion to the amount of heat applied up to the light yellow heat or free scaling point. Instead of the term crystallization, which may not so well portray the situation, let us resort to the one, granulation.

Now the more granulated we are able to make what should properly be a very smooth fracture, the weaker and less able will the steel be to resist the crushing action of the hardness test. Although not that of the scleroscope alone.

Professor Hokanson, of the Carnegie Institution of Pittsburg showed that the old Brinell hydraulic compression test shows, in a general way, exactly what the scleroscope does, to wit: a great loss of hardness when the high-carbon steels (1.10 to 1.75 per cent.) are burnt. These comparative tests, I believe, go a long way toward answering the questions of my contemporaries, or at least it is coming out clear enough to give all a chance to criticise intelligently.

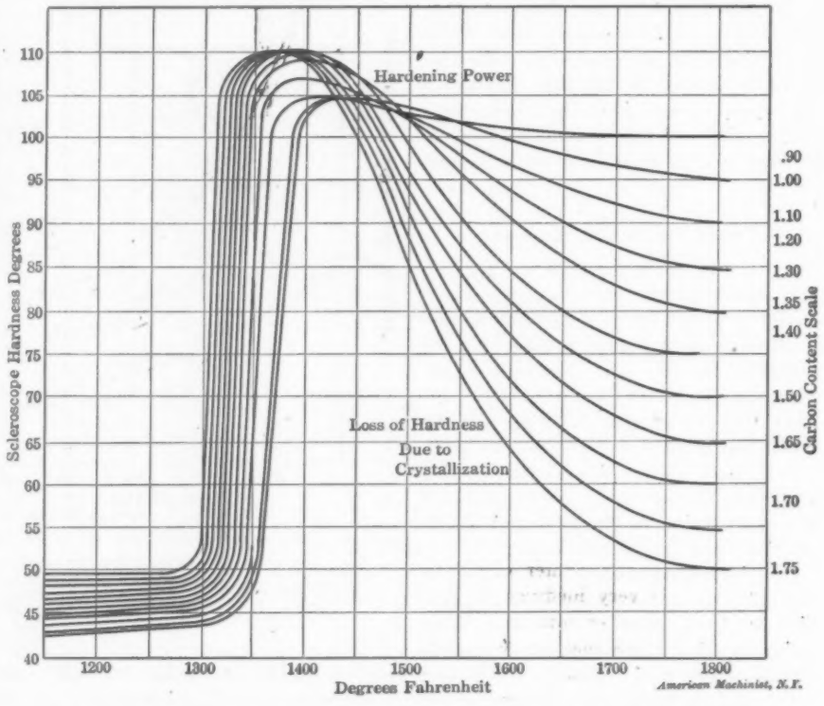


FIG. 1. LOSS OF HARDNESS AT DIFFERENT TEMPERATURES AND CARBON CONTENTS

*Inventor of the scleroscope.

Heat vs. Carbon Content

The discovery has been made many times and by different people, who use the scleroscope, that tool steel, in the hardening, is even more sensitive than a photographic plate. Like such a plate, which is fogged and spoiled with an incredibly small amount of light, so also is steel ruined by the slightest overheating. It would be difficult to explain this delicate puzzle to those who have during all their experience hardened by no other guide than a good red color, a healthy black-gray color after quenching, and the complete immunity of the steel to the file scratch. The surprising part is the treacherous nature of steel, and its refusal to be controlled by anything but good judgment after all scientific apparatus has been supplied to guide the hardener.

Experience has shown, for example, that by the time the heat has become high enough to cause gray spots after quenching, as much as 75 per cent. of the power of the steel has been lost. There was a time when we found much consolation in the fracture test. Now, since we have gone a peg further, it could be shown, with but little trouble, that by the time the heat has become great enough to so change the grain that it can be distinguished by the eye, or microscope, 50 per cent., or more, of the power of the good steel has been dispensed with.

Fortunately, it is possible to detect these stealthy losses in strength and dynamic life by small drops in hardness, which go hand in hand and this is the only clue we thus far have. Those who have thus taken up and mastered the new wrinkle, have, as a regular practice, become able to make tools of old fashioned steel, after selecting only passable stock, that have such very long endurance that no amount of trouble is considered too great to heat treat the steel scientifically correctly, or to first test the stock bar before working it up.

Modern Methods of Testing

As the making of good tools is always costly and the tendency is toward a greater cost of the steel, there are really very good reasons why the last and cheapest operation, which is the determining of the fate of the finished product, is now allowed to cost a bit more, and it is fast becoming an exact branch of a valuable science.

Since it is not in the power of the hardener to make a worthless steel good, it follows that the testing must begin at the stock rack, for chiefly these reasons: To find if the steel is neither too soft nor too hard, representing inferiority, when annealed, and too much cost in machining, refusal to respond to annealing as caused by an excess of manganese, and the carbon content, which, if known, will not only guide the hardener, but will enable the designers to work in the steel to its proper place and satisfy themselves that what they call for is faithfully contained in the stock at hand.

Mechanical Analysis for Carbon

The test for carbon content is made in the shop as follows: A piece weighing a couple of ounces is cut off the bar and heated with a good gas blast, or in a clean charcoal fire, to a light yellow heat, or until a whitish scale starts to rise in large patches at from 1800 to 1900 degrees Fahrenheit, and then quenched in the usual way in water. A similar piece is carefully hardened by the aid of a magnet. To thus get the highest hardness the steel is allowed to get a trifle hotter than the nonmagnetic point; judging by the redness, or, say from 15 to 20 degrees Fahrenheit by the pyrometer.

Before quenching the blast is reduced and the steel allowed to cool off almost to the point of transition, or where it first completely loses its affinity to the magnet, and a strong magnet should be used. When the piece has been thus hardened it is ready to be cleaned for testing. The overheated or crystallized sample must have about 1/64 inch of its surface ground off to remove the decarbonized skin before it is ready for testing.

In order to thus analyze for carbon content, two factors are necessary: a determination of the highest hardening possible in the steel, and the lowest hardness possible due to the overheating within the limits as described. This difference is the symbol that we must go by. It represents substantially the full amount of crystallization possible for a steel of a given carbon content.

Thus we clearly see that since the amount of carbon present in the steel controls entirely the extent to which it will crystallize, as well as the accompanying loss of hardness, we have at hand an infallible mechanical means for analyzing steel for its carbon content, and none other but shop practices are ever involved.

Fracture Method of Determining Carbon

The determination of carbon in tool steels, by breaking it to permit a visual observation of the fracture, has been in use among tool-steel makers for a great many years. The exact conditions requisite for the best results are kept secret by the experts who practice this art. Although this much we do know; that, although the readings obtained are more reliable than the average commercial chemical analysis, the difference in appearance is so trifling, from 0.1 per cent., to another that they can only be discerned by the steel wizards, and that is one too many for us.

The fracture test is now rapidly being abandoned by progressive steelmakers for two principal reasons: (1) My hardness-loss test is far more economical, unfailingly accurate, and anyone can make it and obtain results under instructions in case of emergency; (2) The readings obtained can be understood by both the steelmaker and the consumer and the latter's order specifications can be faithfully carried out.

Thus the scleroscope can do much to obviate many unpleasant disputes arising between chemists representing the steelmakers on the one hand, and the consumers on the other.

In this connection I have found that it is almost impossible for a chemist to find out exactly what carbon a particular steel contains by methods whose costs are within commercial limits. This statement, while rather vilifying in some respects, is none the less a matter of fact and argues well, the difficulty one must face in attempting to systematize things in metallurgy.

Preparing the Test Bars

In order to construct the chart reproduced in Fig. 1 it was necessary to make special steel for each 10 parts of one per cent. of carbon. The greatest care was used to have a Swedish iron, free from carbon, adding a carefully measured amount of charcoal and sealing the crucible so perfectly that absolutely none of the charcoal could oxidize to ashes before combining with the iron. This plan worked very well.

Each specimen of steel thus made was sent to a number of chemists for analysis to make sure, but there was much disagreement in their reports and some were actually absurd. One report gave 0.37 per cent. carbon, where every other test, by crystallization, compound stress, work test, hardening, machining, color, spark and the mixer's record, all showed it to be higher than 1.79, and not more than 1.75 per cent. carbon. A 1.65-per cent. carbon steel most carefully made and mechanically tested, by grains, etc., was found to be 0.87 per cent. carbon by the same chemist. The combustion method was used.

We suggested that the apparatus was out of order, but after making a considerable number of analyses on mild steels, results were obtained which were fairly accurate and which compared favorably with both the scleroscope readings, and the reports of other chemists on the same steel. Some believe that the alkali base used to absorb the carbonic oxide, into which the carbon of the steel is converted, was not perfectly pure and this influenced the results with little chance of knowing to just what extent. It is these chances for error which enter into routine chemical determinations in steel, which had much to do with the demand for a dynamic or mechanical method.

The color test, in which the steel is dissolved in an acid, usually runs into much greater error than the combustion method, and so much so, in fact, that the

fracture test is quite as reliable, little as it can be depended on, owing to the powerful influence of compression and heat treatment.

The goal really sought by metallurgists has been a kind of test which is dependent as little as possible on variable factors, which unknowingly enter. Some means constant enough so that whatever determinations are made, on a given specimen, by one man, the same may be made by any number of others using the same method, in different parts of the country or world.

Measuring Carbon in Mild Steels

In the mechanical determinations of the carbon content of mild steel, a process is used that is exactly opposite the one required for high-carbon or tool steels. The results depend on the hardening power of the metal, when heated and quenched in a manner favoring it most, and the measurement of the slight differences by the scleroscope.

Fig. 2 shows a carbon-content index scale, for mild steel, which has been prepared at great expense and care to comply with the popular demand for this kind of dynamic analysis. The graduated scale is a facsimile of the one in the scleroscope, while the one consisting of irregularly divided decimal numbers stands for points of carbon content.

If we were to pick up any kind of steel, such as bessemer or open hearth, usually called machinery steel in shop practice, and wish to know the amount of carbon it contains, any bright machinist can report to the foreman or master mechanic in a few minutes by merely hardening the piece, and testing it for hardness with the scleroscope, and then comparing with the carbon scale of Fig. 2. Thus, if after hardening a piece of steel it showed a hardness of 55, a line is drawn horizontally across from 55 on the hardness scale until it crosses the carbon scale and where, in this instance, the determination is about 0.23 carbon. If the hardness of another sample jumped up to 90, it would show a carbon content of 0.40 per cent.

Very often, steels that have a higher carbon content than 0.60 per cent., the highest that can be determined by this method with accuracy, will not harden, by quenching, as much as the lower carbon. Such steels would, of course, come under the head of tool steels, which are used in a number of cases, as for needles, hooks, machine parts, etc., where great hardness is not necessary and ordinary mild steel is too soft.

Things That Oppose Hardening

When this is the case, all of the carbon found by chemistry is not regarded as available, due to opposing agents, such as manganese or oxides, which have influences on the formation of martensite or hardenite. As it is important to know which of these two agents oppose hardening, supplementary tests are made.

Manganese, if in excess, will oppose the action of carbon in quenching, for the reason that chilling causes it to anneal like copper, while carbon hardens. Fortunately by the time the manganese is high enough to thus retard hardening by quenching, it will also retard annealing of the carbon, for then it will harden. The extent of this hardening, when measured by the scleroscope, indicates very beautifully any preponderation there may be of this element. Thus manganese, as these excesses go, is not harmful, while an excess of oxides is, and hence the necessity of knowing the difference.

FIG. 2. SCALE FOR OBTAINING CARBON CONTENT OF MILD STEEL WITH THE SCLERESCOPE

The presence of these impurities is found by the hardness measure when, as before, the steel is rated as a high carbon and yet fails to harden and the hardness when annealed is yet normal.

As another illustration of the applicability of the mechanical test as an aid to the determination of the chemical constituents of steel the following is of interest. If steel of the proper carbon content, but under 0.90 per cent. hardens properly but yet fails to anneal satisfactorily we know that manganese does not preponderate but that the cause lies in the presence of phosphorus. This element is bad for steel in that it causes brittleness. If the measured difference is so slight that one is left in doubt as to which of the two, phosphorus or manganese, is in power, we have still a very powerful factor to resort to, as by bending a test piece. If the manganese is high, since it is a deoxidizer and cleaner, the steel will bend a great deal before fracturing, while if the phosphorus is high, but little bending is possible before the piece fails. The fracture, which is coarsest for the phosphorus and finest for excess of manganese, may also be taken into consideration where differences are slight enough to lead to doubt.

Effect of Alloying

Everybody is naturally interested to know just what influence, such special metals as nickel, chromium, vanadium, silicon and tungsten will have on the dynamic test for carbon. Nickel up to nearly 4 per cent. in steel does not interfere very much although if higher, the carbon determinations will read low, owing to the opposition of the nickel to the hardening by carbon.

Chromium, if used in commercial percentages, whether alone or in combination with nickel, does not oppose the action of carbon. Vanadiums, when used only to purify, favors it. Silicon does not oppose carbon if in commercial percentages. Tungsten does not oppose the action of the carbon in hardening very much, although if only a small percentage is added to very high carbon steel, with which it is sometimes mixed, it throws us off in our tests for carbon by the crystallization method. Strength is lost by overheating, but it does not crystallize much and therefore does not lose much hardness. But for all this tungsten cannot be added in small quantities without detection with ease.

Tungsten, even when a very little is in the steel, can be detected by its peculiar power to arrest the bright starlike carbon sparks caused by grinding on an emery wheel, or when the filings are thrown into a flame. These sparks will then resemble the dark red and simple straight lines as caused by high-speed steel.

When tungsten is to be determined by the hardness method as in high-speed steel of which it is the backbone, it exhibits the strange power of causing red-hot steel to retain high hardness or what is called red hardness. It was the discovery of this property of tungsten that finally led to the invention of high-speed steel.

Analyzing for Tungsten

To actually analyze for tungsten by the dynamic method is more of interest to chemists than to shop men, for it is more difficult than finding carbon. Nevertheless hundreds of shops using the scleroscope are now testing out high-speed steel for red-hardness, for it is this property

which determines how fast the steel will be able to cut and also how hard material it will cut.

The rate of cutting is controlled and limited by the amount of heat generated, while the hardness of the stock is limited by the hardness of the tool, and the accompanying toughness of said stock. For this reason high-speed steel is tested for hardness while at a heat of 600 to 800 degrees Fahrenheit.

Thus, suppose a high-speed steel having a hardness when cold of 95, and when heated to about 800 degrees Fahrenheit, the hardness at that temperature should drop to about 70, which is hard enough to cut mild steel. This drop of 25 points is due to the temporary effect of the heat on any body, as there is no such permanent loss due to a chemical change or temper drawing.

As a comparative example, a carbon steel, whose initial hardness is 95, when heated to 800 degrees Fahrenheit will lose not only the 25 points in hardness due to the presence of the heat, but also about as much again due to the permanent chemical changes or temper drawing. High-speed steel, if perfect, will not experience a permanent chemical change, as experiments on good steel clearly show. When thus a tool is required, where maximum strength is desired, it is not possible to get the full allotment of red hardness, for the latter only develops after so highly heating as to cause crystallization. However, when strength can be spared a reheating of 800 degrees Fahrenheit will not draw the temper more than from 3 to 5 points in hardness.

Duplicating Work on the Surface Grinding Machine

By J. Vass

Having occasion to grind a number of castings to the same thickness on a Brown & Sharpe surface-grinding machine, I hit upon the following plan of keeping the wheel straight (this was necessary as the work was ground up to a shoulder) and at the same time keeping the cutting surface of the wheel always the same distance from the table of the machine when finishing: I made an adjustable holder for the diamond used for dressing wheels and fixed it in such a position on the table of the machine that during part of the stroke it came under the wheel. Having set the diamond to the hight required with the hight gage, I fed the wheel into the work until it almost touched the diamond. I then dressed it and finished the work. Several hundred castings were ground in this manner and the device worked very satisfactorily. Since then it has been used on other kinds of work with like results.

Echoes from the Oil Country—A Chapter of Accidents

By W. Osborne

There is no doubt about it. Tim was green when he went to work in the machine shop. This fact was a source of delight to the other boys, and at times it seemed that some of the men could see a funny side to many of the accidents that befell him. It surprised him to find how cold a piece of iron could look and still be hot enough to be hastily dropped when incautiously picked up. The necessity of so developing the skill of the right arm that the hammer used by it would line up properly with the chisel which was held by the left hand was forcibly presented by the big bloody lump just back of the knuckle of the first finger, assisted by the ache that ran up to the elbow. This ache, at the moment when the hammer missed the chisel and stopped on the aforesaid lump, had a way of going clear to the shoulder, and leaving an impression that was far from agreeable. How some of the boys would howl with delight when Tim found it necessary to drop the hammer, tuck his left hand into the arm pit of his right arm, hunch his shoulders, clinch his teeth and make a wry face. Even the boy who had a big scab on his left-hand knuckle, and who was afraid to strike half a blow used to join in.

It did seem that most things in the machine shop had a grudge against him. His hands showed the marks of threads of various pitches where they had cut through the skin. Steel chips seemed to be just right to make slight cuts, and the chips from the milling-machine cutters were worse than hemlock slivers. His big toe was directly under the piece that fell from the drill-press table when he moved another piece against it, and that piece hit squarely in the center of the nail, or at least that was where the black spot was when he got his shoe and stocking off.

An accommodating workman bored a hole through the nail with the point of his knife and let the blood out. For a few days Tim was constantly conscious of the location of at least one of his feet.

Tim had been an ordinary healthy, active boy before coming into the shop. He had gone through the usual course of bumps, slivers and knife cuts without making any more fuss than other boys. The injuries which he was receiving were not so bad, but he was receiving them in unfamiliar surroundings.

Tim Gets a Finger into the Back Gears

He had arrived at the dignity of running a lathe. It was a nice little lathe with a clutch countershaft and a straight and a crossed belt. The clutch on this countershaft was not a friction clutch but a positive clutch. The older workmen spoke of it as a "jaw" clutch. It could be thrown in whenever the projections of the sleeve came in line with the openings in the hub of the pulley, and it could be thrown out whenever the shipper was pulled hard enough.

Tim was cutting threads on the ends of some pieces. These pieces were ⅝ inch in diameter. Owing to lack of skill Tim had larger centers in these pieces that the job required. He had square centered them and was not very skilled at it. Owing also to a lack of skill at such work he was running with the back gear in. He had not, as yet, acquired the skill to manipulate the tool with one hand while he worked the shipper with the other so he found it necessary to stop after running back to the place of beginning and let the lathe stand while he set the tool in for the next cut. It was hard for him to have the lathe stop at the right place.

If he did not jerk hard at the shipper it might not come out and if he did jerk hard and it came out easier than he thought it was going to it was apt to move so far that it would catch on the other pulley and start the lathe ahead. If it did not come out it would run the tool up against the center and break the point off before he could give the second pull.

This breaking off the point of the tool by striking the center got to be serious, for it was a big job for Tim to get it back into shape again.

To keep this from happening Tim began to use his hand on the largest step of the cone for a brake. It was easy to do this with the lathe running backward, and it was also easy to overdo the matter and do the final stopping with one of his fingers in the back gears. This happened and part of the nail was gone and the end of the finger was nicely chewed up.

Tim's mother was not near at hand with the supply of rags that Tim had been used to in such emergencies, but an hysterical workman who got white and trembled at the sight of blood was there. He saw visions of all sorts of horrible things up to Tim having to have his arm cut off.

This man pulled out a red bandana and wrapped it around Tim's hand and hurried him to the door. "Git right down to the doctor as fast as you can. The quicker you get there the better." The goose flesh began to crawl over Tim and he hurried. The doctor did not have anything good to say about that red handkerchief. With professional forethought he did not treat the injury lightly. Who could tell what might develop before it was well? He did wash it off with care, treat it with some liquid that deadened the pain and tie it up. Tim was directed to report the next day at about the same time.

"Wouldn't it do if I came in the evening?" asked Tim. "I don't like to get off in working hours."

"You must not go to work with that hand. You must carry it up so that the blood will not settle in it. I will let you know when it is safe to go to work. It would heat your blood if you went to work."

Tim went away realizing that to be hurt in a machine shop bad enough to get into the hands of a doctor was a very serious thing. Once a boy had hit him on the head with a pick and put him out of commission for a time, but he went on playing with a big lump under the mass of matted and bloody hair, whenever it didn't hurt too bad. He forgot what did happen to that hurt finally or when it got well. Now, Tim was an orphan and lived with his mother. A machine shop, to his mother, was a place of mystery. When he told her how he had been hurt and how he had been hurried to the doctor she felt that it was a case beyond her skill. Tim continued to go to the doctor. Ten days after the hurt that finger was still in bad shape and had not made much progress toward healing. In visiting the shop one day Tim learned that the boss was planning to put another boy at the job which he had been on. Before leaving the shop Tim told the boss that he would be at work in the morning, and he was, and at the same little lathe. How everything did get in the way of that finger. About nine o'clock the boss came up.

"I guess you had better go home," he said.

"What have I been doing?" demanded Tim.

"Look at that finger and at the floor."

Tim did not need to look. He knew that the blood was dropping from the end of the finger and showing on the floor. He kicked some chips over the blood on the floor. "I hain't going to lay off any more with that finger," he muttered, and kept on with his work.

By noon the cloth around the finger was hard and after his mother had got one round of it off Tim decided that he did not have time to have more off then and had her put a clean cloth around it. That night his time was also limited and when that dressing did finally come off it slid off because it was not needed.

If account had been kept of all the accidents which befell Tim in the first few years of his work it would have been a long one. He regularly kept a bundle of clean white rags and a package of court plaster in his tool box, and the supply had to be renewed frequently for it was used as common property.

In all of the accidents which have befallen him since that time Tim has been in the hands of the doctor just once and that one time it was necessary to sew up a bad cut. This cut was not received in the shop, and after it was sewed up Tim kept away from the doctor.

Tim's Method of Treating Injuries

It would appear that owing to the dirt that is around a machine shop there would be great danger of blood poisoning from these minor accidents, but experience has shown that such is not the case. In the case of Tim his standard treatment for a cut was: wash it with the soap which he used in the shop, wrap a cloth around it and then wet the cloth thoroughly with a mixture of about one-half of a teaspoonful of carbolic acid to a pint of water. This wetting was kept up until the cut quit hurting. If it began to hurt again from being used more of the mixture was put on. He did not quit work. He never had any trouble with any poisoning nor did he ever know of a case among his fellow workmen who did the same as he did.

He did know of several cases where men who received slight hurts laid off and boozed and had a very serious time.

I asked a mother who was successfully giving first aid to the injuries of four active youngsters how many accidents a year she averaged with them. She thought the accidents were very few until I explained that every cut that required a rag was an accident, that every bump that required camphor was an accident, that dirt that had to be removed from the eye was an accident, that abrasions, and slivers, and burns were accidents.

If she were to furnish you with a classified list of all the accidents which befall her four you might be led to think that home is a very dangerous place for a child. One week just passed there were ten accidents serious enough to be remembered. It may be urged that these children are not sufficiently warned by their mother. Certain it is that they climb fences and trees, swing on the clothes lines, and make architectural monstrosities out of old boxes and other trash. They have knives, hammers and even a hatchet, and the mother is not threatened with nervous prostration. The time when she is uneasy is when children who have been kept "in a bandbox" come to play with hers. Then she wants to gather in the knives, hide the hatchet, and keep an eye on the fences and trees. She knows that talking will not do for these children. They must learn by experience and if the experience is not had with harmless things it will be with dangerous ones. She prefers that they do not get the experience on her premises.

Chick's Injury and that of His Shopmate

A man got his finger cut over at the shaper. He was a man who felt that he was too good for shop work and the men knew it and that finger did not get shop treatment. It, or something, scared him so that he went around for a long time with his hand tied up, but he never came back to work. Chick was put onto the job. Chick was a harum-scarum kind of kid with a good-natured grin on his face and a faculty for having a hand in all the fun going. The machinist at the bench near the shaper explained very carefully to him that hands are not intended to be used as brushes to remove chips from before a moving tool, and pointed out the horrible fate that had befallen the man who had been doing it on that very machine.

Chick remembered for several days, or at least it was several days before the machine caught him at it and nipped away a bit of the fleshy part of a finger just like it had done for the man.

Chick gave one howl and then stuck the finger in his mouth and sucked it until the worst of the hurt was over, then he went to the shop surgeon and had it wrapped up and wet down. After that he went to work again. If he lost any time on account of that finger it never showed up on the time sheets that he turned in.

Dave got the meaty part of his left hand badly torn by a piece of rusty iron that caught on a drill and was jerked out of his hand. The shop surgeon grunted a little when he saw it but washed it out carefully, using the "dope" for the final cleansing. He also gave Dave a bottle with some of it in so that he could keep the cloth moist, and Dave went back to work.

Shortly after that one of the men struck the same part of his hand against a sharp edge and cut it. It was a clean cut and not as deep as the one Dave had received but the shop surgeon positively refused to dress it. The man went to a doctor. Dave was surprised at the refusal and asked for a reason. "That cut is a serious thing. You watch and see. I will tell you all about it some time." That was all the satisfaction that Dave could get at the time. The man did have a bad time with the cut. The hand and arm swelled up and the cut refused to heal. He finally left town to go to the home of his parents.

Dave again pressed the shop surgeon to know why he would not dress that cut.

"You see it came out like I told you it would, didn't it?" Dave nodded assent.

"I knew that it would. In the first place that fellow didn't have any sand so you might be sure that he would lay off and loaf around. His folks don't live here and he is staying at a boarding house so that in his spare time he is hanging around the street corners or else is in the saloons, and that means that while he is loafing with that hand he will be drinking even more than he usually does, and while he is drinking the hand will not heal. Now you are so poor that you have to work whenever you can and you live at home and I never saw you hanging around with a tough gang nights. Your hand got well right along. His didn't. It couldn't and I wasn't going to be blamed for it."

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Homemade Internal Grinding Machine

The accompanying sketches show a machine which we made some time ago for grinding out gray-iron bushes 4 inches in diameter by 12 inches long. We had a large quantity to do and being a standard product they were continually coming through the shops. Our existing grinding plant was overtaxed with work, which state of affairs we did not expect to last very long, hence the call for a machine which would assist us to tide over our busy season, and one that, at the same time, would do a good accurate job and could be constructed at a moderate price. The machine here shown has quite fulfilled our expectations and saved its cost many times over; it is now in continuous operation on work on which it has effected a great reduction in time over our former method. Of course it will not take a wide range of work, being designed for internal grinding only.

Referring to Fig. 1, which is a side elevation of the machine, *A* is the bed which we made from an American lathe bed having two raised vees; *B* is the head which carries the spindle *C* on which is mounted the double flanged driving pulley *D* and to the nose of which is screwed the adapter plate *E* for mounting the chuck. *F* is the saddle which carries the screw-actuated, adjustable bracket *G*, which is bored out to receive the spindle *H*, which carries the grinding wheel *I* on the end, as shown. *J* is the flanged driving pulley, secured on the shaft by the headless screw shown. *K* is the box containing the feed and reversing mechanism, also shown with the cover removed in Fig. 3, and in end elevation in Fig. 4. *L* is the driving shaft with a key L^1 let into it, and *M* is a driving pulley, keyed on to this shaft. *N* is a sleeved bevel gear, held securely in position by the two threaded locking rings *f f*. The driving shaft *L* passes through the bore of this gear, in which it is a free running fit. Gear N^1, is similar to *N* and is held in position by the two locking rings *e e*. N^2 is a bevel gear connecting *N* and N^1 and also acting as a reverse wheel by rotating *N* and N^1 in opposite directions.

The end of the shaft *L* is supported in the bore of the pinion N^1, in which it is a nice running fit. *O* and *P* are two case-hardened steel clutches securely fastened to the bosses on the inside faces of the gears *N* and N^1, by countersunk head screws. *Q* is a case-hardened double-faced steel clutch member, which has a channel around the periphery, as shown, for carrying the operating gear, and a keyway in the bore, for sliding on the key L^1, in the shaft *L*. The faces of the clutch member *Q* engage alternately with

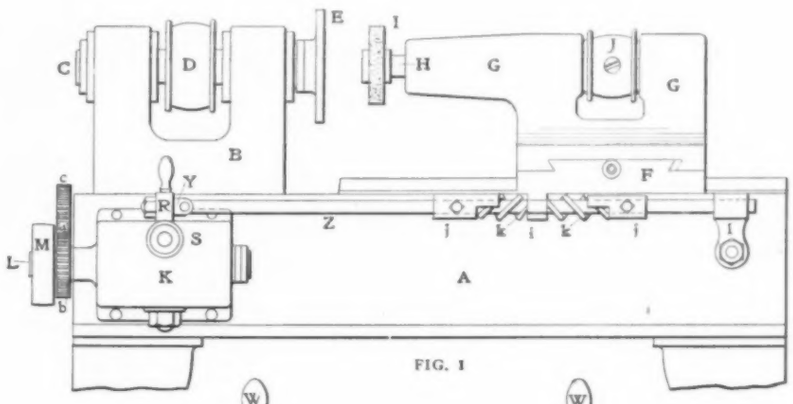


FIG. 1

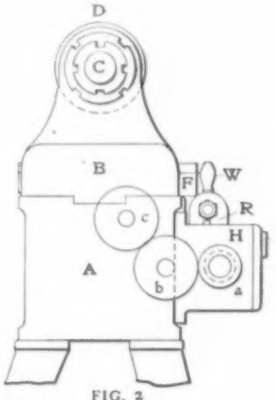


FIG. 2

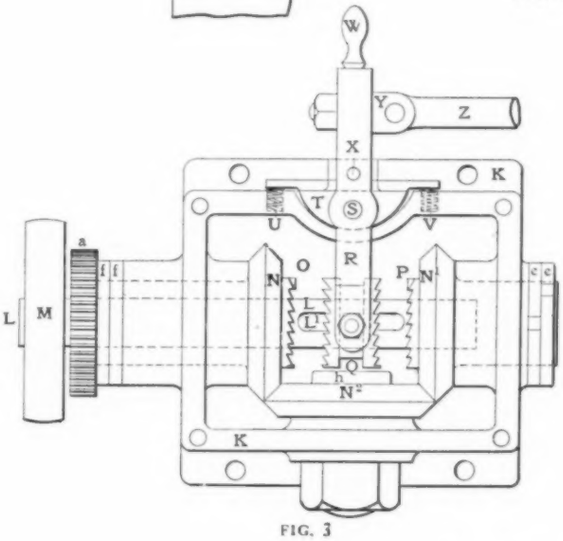


FIG. 3

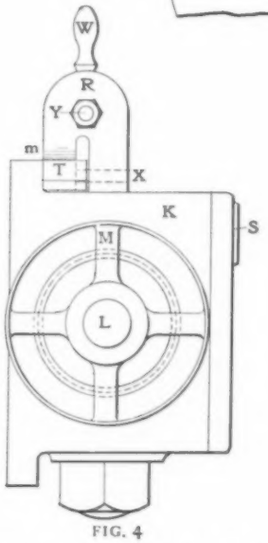


FIG. 4

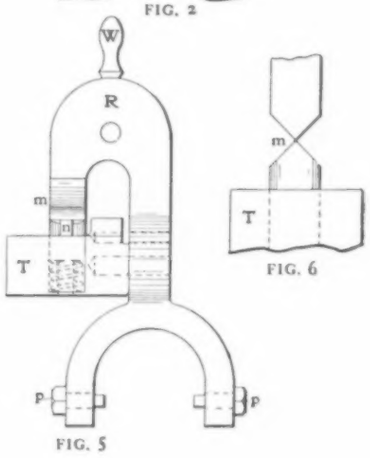


FIG. 5

FIG. 6

American Machinist, N.Y.

HOMEMADE INTERNAL GRINDING MACHINE

the clutches *O* and *P*. *R* is a steel-operating lever, pivoted on the pin *S*, which is let into the rocking steel block *T*. This block fits into a cradle-shaped recess, cored in *K* and touches only on the bottom, there being about ⅛ inch clearance at each side toward the top. This block is held loosely in position by two small screws, passing through the lugs at each side and into *K*. At *U* and *V* are two coil springs, let into *K* and acting against the lugs on *T*. *W* is the handle by which the operator controls the direction of the feed and also stops it when required by setting the clutch *Q* in the neutral position, as shown in Fig. 3. At *X* is a pin hole for locking the handle *R* in neutral position when not in use. *Y* is a forked-steel joint secured to *R* and *Z* is the feed trip rod, which is coupled to it, as shown.

A spur pinion *a* is keyed on to the end of the sleeved bevel *N* and this pinion gears with the intermediate wheel *b*, shown also in the end elevation, Fig. 2. Gear *b* drives *c* keyed on the feed screw, which passes on one side along the inside of the bed, so as to clear the bolts which hold down the head *B*. This arrow passes through a nut secured on *F* and thereby gives motion to the grinding head *G*. A lug *i*, which is cast on *F*, slides along the inside of the rod *Z* and operates the trip dogs *j j* and compresses the springs *k k*. These trip dogs are, of course, adjustable, being secured on the rod *Z* by square-headed screws. A swiveling bearing is provided at *l* for supporting the end of the shaft *Z*.

In Figs. 5 and 6 is shown a case-hardened knife-edge *m*, which is machined at an angle of 90 degrees on the lever *R*; this bears against a hard steel plunger machined to a similar knife-edge and let into the block *T*, the plunger being prevented from turning by a small key, let into *T* and into the keyway *n*, shown in Fig. 5. A coil spring under plunger *m* presses the plunger knife-edge up against the one on *R*. The two set screws *p p* passing through the fork on the end of *R*, have hardened ends, reduced to the bottom of the thread, and protruding on the inside of the fork to receive two phosphor-bronze square blocks, which are bored out to fit them and also shaped to a nice sliding fit in the groove cut around the center of the clutch member *Q*, whose movements they control.

In operation, the driving pulley *M* imparts motion to the bevel gears *N* and *N'*, inside the speed box *K*, through the medium of the clutch *Q*, which, in turn, transmits it through the spur pinion *a*, to the feed screw, onto which the gear wheel *c* is keyed. This imparts motion to the saddle *F* which carries the grinding head. When traveling along the bed, the lug *i* comes in contact with one of the springs *k* and compresses it until reaching the face of dog *j*. It then begins to carry *j* with it, and as the dog is secured to the rod *z* it also slides that rod along and moves the lever *R*, with the knife-edge *m*, which is thus forced up the inclined side of the bottom plunger in *T* until it reaches the center, as shown by Fig. 6; at that instant the block *T* rocks slightly, due to one of the springs, *U* or *V* (according to the direction in which *F* is traveling) being depressed by the action of *m* in forcing itself, or being forced, over the plunger. This action instantly is assisted by the combined energy of the bottom spring under the plunger and the spring *k*, and also the spring *U* or *V*, which force the lever *R* over and reverse the movement of *F* by engaging the opposite side of the clutch *Q* with the corresponding bevel gear. Thus an instantaneous reverse is obtained, the movement of the clutch *Q* being assured by the knife-edge *m*, on the lever *R*, which is always in contact with the angular sides of the bottom plunger which thus acts in conjunction with, and gives additional energy to the springs *k*. This mechanism has given us no trouble in continual hard service so far.

Oldham, England. TEXTILE.

Wanted—A Method for Upsetting Seamless Tubes

I should like to ask through the columns of the AMERICAN MACHINIST, what is the best method of upsetting seamless drawn tubes for reinforcing them, the outside diameter to remain the same as the body of the tube, the upsetting to extend about 3 inches and to increase the thickness of the wall ⅜ inch?

Orrville, Ohio. C. R. SMITH.

Removing Foreign Substances from the Eye

Not long since the writer was greatly relieved with no discomfort whatever, by a fellow workman, who with a small piece of copying paper removed from his eye-ball an obstinate intruder. The use of paper, while it may not be new to many is effective and absolutely harmless since the tissues of the eye cannot easily be scratched nor irritated by it as is sometimes done with a more rigid instrument, such as the end of a match or toothpick which is so often used. The paper will be more effective if moistened and almost any thin clean piece can be used.

J. C. A.

[When we were in the shop we were official oculist and in that capacity used toothpicks, horse hairs (twisted), paper, etc. In many cases the foreign body, such as emery, was so firmly imbedded that the point of a needle or scriber was the only thing which would move it. We have seen small pieces of steel which resisted removal by a powerful electromagnet and yielded only to the scalpel.—ED.]

Shaping an Arc on a Boring Mill

Having an order to build a twelve-foot centrifugal ventilating fan in which the inner edge of the jaws *A*, Fig. 2, had to

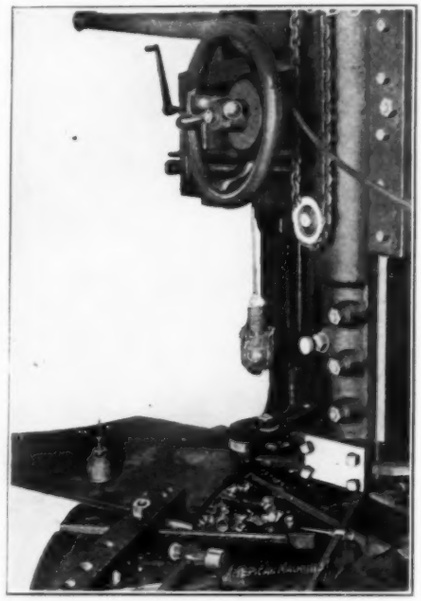


FIG. 1. THE ARM ON THE BORING MILL

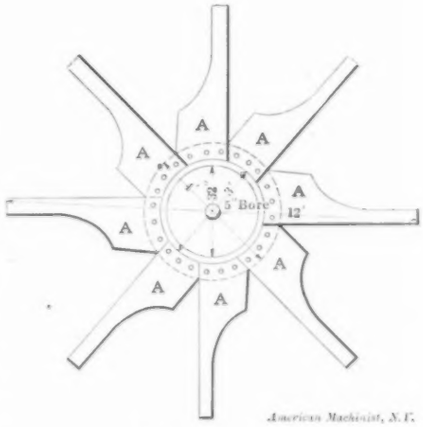


FIG. 2. THE FAN

conform to a 36-inch circle, and on account of the length of the jaws, I had no mill on which to do the job.

The jaws *A* were sheared out to shape. I then laid them on the hub, and laid out the arc with a pair of trammel points, then taking the jaw to a 7-foot mill (the largest in the shop) I drove a center in the bore of the table and set the jaw with the trammels. The jaw was clamped to the table as far back as the housing would permit and I set the tool so that it would

start cutting as soon as the power was applied. Fig. 1 shows it in operation.

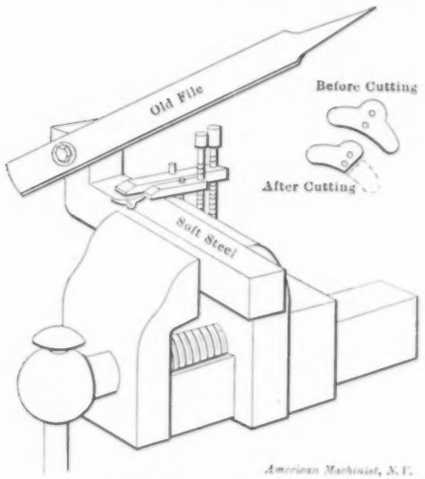
As soon as it traveled the distance of the cut, the machine was stopped, the tool run up so as to clear the work, the gears thrown out, and I pulled the table back by hand. After running the tool down again, I was ready to take another cut and repeat.

This sounds rather lengthy, but with one helper it took me only about 15 minutes to the jaw.

Osceola, Penn. JOHN L. MCCANN.

An Improvised Shear

While making some special switches it became necessary to cut 600 pieces of 22-gage spring brass, as shown in the small figures. A brief trial with the snips quickly demonstrated the fact that they were too slow and that it was practically impossible to cut two alike. As this was the only job of this kind likely to come in, it would not pay to make any elaborate tools for the purpose, so after a few minutes "deep thinking" a visit was made to the scrap heap and old file box, where the bent piece of soft steel was resurrected, and a 10-inch mill file was found. The steel was put in the shaper



AN IMPROVISED SHEAR

and a cut taken over one side to straighten it up and the teeth were nearly ground off the file while the shaper was running. The temper was then drawn on the end of the file and a hole drilled for a 3/8-inch cap screw, which was tapped into the soft steel. This completed the shear, which worked well, the remnants of the teeth on the file holding the brass so that it did not slip, and when the edge of the soft steel became dull a couple strokes with a file put an edge on it equal to new.

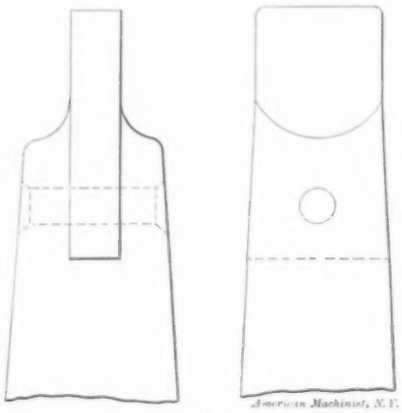
Two machinist's clamps were used to form stops to hold the stock in position and the whole outfit clamped in a vise. The time occupied in making the shear was not over one hour and it only required sharpening twice for 600 cuts.

Syracuse, N. Y. E. Q. WILLIAMS.

Renewing the Tangs of Drills and Reamers

Nearly all shops, large and small, have wrestled with the problem of how to make use of drills or reamers with broken or battered tangs and many methods have been shown in the AMERICAN MACHINIST.

Here is a method that has been used for many years by our superintendent



RE-TANGING DRILLS

Henry De Smith, and the actual money saved in this way is surprising.

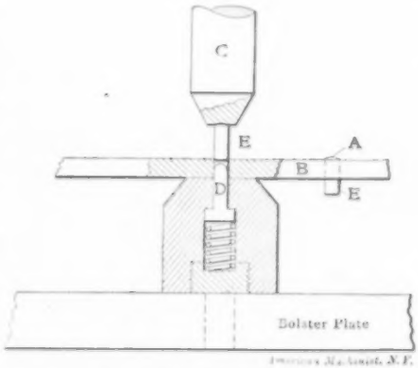
The cut is self-explanatory. The broken tang is milled straight through the width of the cut depending on the size of the drill. A piece of tool steel is then set into the cut, drilled and pinned in place.

After dressing the edges with a file the drill is "better than new," (meaning a tang that will outlast the original) and at an expense of only a few cents.

Rochester, N. Y. RALPH W. DAVIS.

Inserting Dowel Pins by Means of a Punch Press

We have a large number of cast-iron plates which have a 3/16-inch dowel pin driven into each of them. Until recently the dowel pin was driven into the plate with a hammer with the result that a large percentage of the pins were battered out



INSERTING DOWEL PINS

of shape on the end. I show herewith a fixture which was made to assemble the pins and plates on a foot press in much less time, and instead of the end of the pin being battered we now have a nice crown, as shown at *A*.

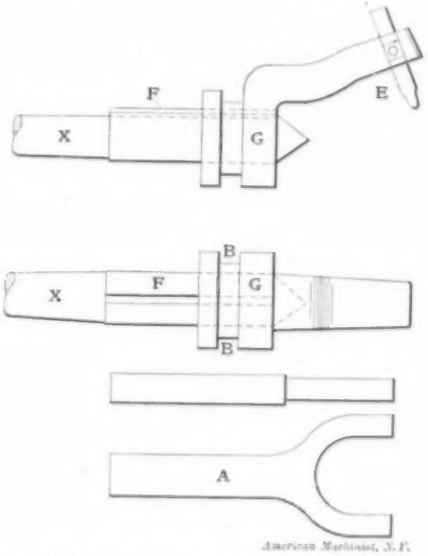
The drawing shows the dowel pin *E* about to be assembled into the plate *B*. The chamfered end of the pin is placed in the hole in the plate and forced into the plate by the punch *C*, while the disappearing pilot *D* guides the pin and lines up the hole.

SUBSCRIBER.

Philadelphia, Penn.

Tool for Turning the Ends of Shafts

The line cut shows a tool for turning the ends of shafts with arms too long to swing in the lathe. The center *X* is made to fit the lathe spindle. The yoke *A* can be made to suit any tool post and the end for the tool *E* can be made to take the size steel you have at hand. A key *F* is fastened in the center, as shown, and a keyway is put in the sliding head *G* so



TOOL FOR TURNING ENDS OF SHAFTS

it will turn with the center. The head *G* should be a neat sliding fit on the center and key. The yoke *A* should fit the groove *B B* snugly. When the yoke is fastened in the tool post the feed can be put on in the usual way.

Stroudsburg, Penn. W. H. S.

Gluing Leather to Iron

It was required to glue a strip of leather to a cast-iron bar. Ordinary patternmaker's glue and seccatine were both tried but without prolonged effect. The following glue, however, was a complete success and has served the purpose in similar jobs and as a special patternmaker's glue: Best

ground glue 2 parts and acetic acid 1 part. Glue dissolves when acid is heated. Mix well *together and apply.*

Glasgow, Scotland. J. H. J.

Textile Machinery — A 60-year Old Bearing and a Rotary Engine

I stopped in at the Mechanics' building, Boston, the other day almost as a matter of habit, attracted by a poster stating that an exhibit was being held by the Textile Exhibitors' Association. The exhibit while, of course, a mechanical one, had many features of interest to people in the textile line, but not to the readers of the AMERICAN MACHINIST. Yet there were a number of things of interest from a shop point of view.

One of these was an exhibit of the courses and work of the Lowell Institute for Industrial Foremen. That school is engaged in taking young men out of the mills and training them to be foremen and overseers. The conditions are not entirely different from those that we are meeting in attempting to get trade schools for machinists, so I will save a few comments for another letter.

The mechanical detail of most of the machinery exhibited seemed to show that the practice of chipping textile frames to fit is not universal by any means. It is not so many years since I tried my hand at planing a lot of loom sides. They were large ones, larger than anything shown here, but I would like to see anyone make the time chipping on them that we did planing. There were spots for the end of cross struts on one side, and spots for the feet of brackets on the other. The time was something like two hours to a pair, most of it in setting the job on the planer. The cross-bars were all milled to length and were practically interchangeable; there was not the slightest doubt that the time of making a machine job of these fits was less than chipping, and the advantage of interchangeability was certainly worth the running expense of the machine. There was, of course, no time spent in changing tools and roughing and finishing. We used high-speed steel, flat-nosed tools with the corners well rounded. The roughing and finishing was all done at once; that is, once over with hand feed according to the depth of cut and then back with the spring of the work giving us the depth of finishing cut.

TEXTILE MACHINERY IMPROVING IN WORKMANSHIP

Textile machinery, at least that which was exhibited, is approaching a little more nearly to machine-tool practice. They still have the ends of solid boxes rough—where no collars come against them—and the fits on rotating shafts would undoubtedly give a toolmaker another kind of fits. On the other hand, there is room for oil, and since a bearing depends for its life on oil there seems to be no good reason for making close fits where the only result would be machines tied up with hot boxes. I believe we could make a great number of journals loose in their boxes with advantage; the bearings for planer shafts, for example. As a relic of chipping days, almost all box seats consist of two narrow ridges planed off. Why this could not be done equally well in similar places on machine tools I do not know. No doubt the first builder who tried it would have hard sledding, but persistence might accomplish just as much as it did in the case of lathe aprons; it is not many years since the polished, oil-stoned surface was discarded for a painted one.

A SHAFT BEARING THAT HAS WITHSTOOD 2,700,000,000 REVOLUTIONS

William Sellers & Co. show an exhibit of quarter-turn belts with nothing new unless it is the greater adaptability of some of their boxes. They do show several cast-iron bearings that have been running for years, the most notable one being a 3½x14-inch bearing that has run 2,700,000,000 revolutions. It was a good object lesson in cast-iron bearings. It was not ring oiled, just two oil holes, ½ inch diameter about 5 inches apart and two 1½-inch grease cups near the ends. There were some very fine scratches near one end, nothing more than might have come in the first 10 minutes that it was run. It was nicely glazed all over. Considering that the oiling was undoubtedly by man power, it is incredible that it could have run the whole of 60 years without having been neglected occasionally.

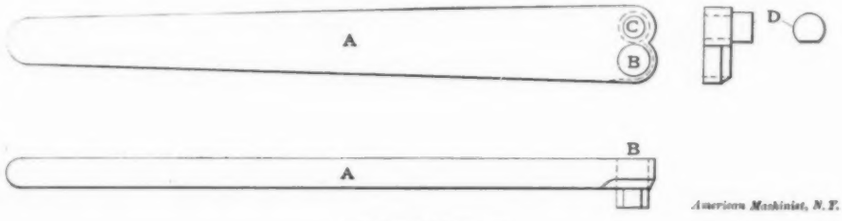
Freak machines were scarce. One loom was shown using a sort of crochet-hook device for pulling through the filling. It reaches between the threads of the warp, catches in a loop of the filling, cuts off one side of the loop and pulls it through and holds it in tension until the warp is shifted to hold it tight. The principal advantage claimed is that a larger number of colors can be used; the only attachment necessary for color weaving being a stand for spools of thread and a cam device for presenting loops of each color after the proper number of strokes. It has the disadvantage of not leaving any selvedge edges, which Mrs. Entropy says will kill the sale of the goods, though possibly the objection is no more valid than that of buyers of machine tools who want everything the way their fathers used to buy it.

Another exhibit that I suppose the owners would object to having classified as a freak was a rotary engine claiming the "unprecedented" record of 42 pounds of steam per horsepower-hour. The attendant told me that no other engine under 6 horsepower ever made such a record. I had the curiosity to look up some old tests that I made 15 or 20 years ago on a reciprocating engine which showed 4.87 horsepower on 28 pounds of steam. The engine is very smooth running, compact and neat appearing, but it does seem as if it ought not to be exploited on the basis of steam economy.

Springfield, Mass. ENTROPY.

A Die Drilling Jig

Drilling jigs for roughing out dies have been used for many years, but are not known half as much as they should be. A die drilled out with a jig has not nearly so much stock left to mill, chip and file out as a "mark off and drill die."



A DIE DRILLING JIG

The cut shows such a jig. The stock *A* is of tool steel ⅛ or 3/16 inch thick, depending on the size drill the jig is for. The centers of the holes *B* and *C* are laid off 0.002 inch farther apart than the diameter of the drill to be used in the jig. The hole *B* is drilled and reamed to suit the drill. The hole *C* is smaller and a locating plug of drill rod, the same size as the drill, is turned down to fit and rivet into it. The stock around the hole *B* should be filed as thin as possible and leveled on the under side to about 0.010 inch thick. Harden and temper the end of *A* and the plug end of *D* and rivet *D* in position. Grind a flat on the plug *D* on the side near the hole *B*, so that the peening action of the drill in the next hole will not jam the plug so that it cannot be easily lifted out.

The method of using the jig is obvious. A hole is drilled near the blanking line. The plug is inserted and the jig swung around until the beveled edge around the hole *B* coincides with the blanking line. Drill the holes ¼ inch deep, and start all the holes in rotation with the jig. After drilling all the holes a blow with the hammer will cause the scrap to drop out.

Brooklyn, N. Y. F. J. B.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

A Problem in Stresses

The problem in stresses which appears at page 662 seems at first sight a poser, and perhaps it is such. In the following solution I have, for purposes of clarifying the subject, started with a simple form, then modified it until it represented the conditions of the specific problem given by Mr. Norman.

First, consider a hollow cylindrical ring subjected to internal pressure. See Fig. 1. There are two ways in which failure could occur; one half could separate bodily from the other half, the rupture occurring on the line $m\,m$. Let S = stress caused by this action. Or failure might occur by one half separating bodily from the other half on the line $n\,n$. Let S_1 = stress due to this cause and let p = the internal pressure. Then

$$S = \frac{\frac{1}{4} p \pi d^2}{\pi t (d + t)} = \frac{p d^2}{4 t (d + t)}, \quad (1)$$

and

$$S_1 = \frac{p \pi D d}{\pi (D + d + t) t + \pi (D - d - t) t} = \frac{p d}{2 t}. \quad (2)$$

Thus S_1 is approximately twice as great as S. Now the stresses S and S_1 are both tension and act at right angles to each other; their resultant or combined stress may then be found in the usual graphical method of resolution of forces or by the equation

$$S_2 = \sqrt{S^2 + S_1^2}, \quad (3)$$

where S_2 is the resultant combined stress.

Now suppose the inside of the hollow cylindrical ring to be cut as indicated at C in Fig. 2 and the fluid prevented from escaping at this aperture by the gasket g; further that the inside edges are reinforced or stiffened by the addition of a heavy flange f. The force tending to separate one half bodily from the other on the line $n\,n$ is the same as before, but the amount of material resisting it has been decreased and the resulting stress is now

$$S'_1 = \frac{p \pi D p}{\pi t (D + d + t)} = \frac{p D d}{t (D + d + t)} = \frac{p D d}{t D_1}. \quad (4)$$

Similarly the load sustained by the metal on line $m\,m$ (as in Fig. 1) is the same as before but the area of material resisting it has been increased by the additional metal in the flanges f.

Let A = area of material section-lined in section $m\,m$ of Fig. 2, then

$$S' = \frac{2 p \frac{1}{4} \pi d^2}{A} = \frac{p \pi d^2}{2 A}. \quad (5)$$

In addition to the stresses S and S_1 there is a bending action upon the material cut by line $n\,n$ and if dimension D were infinite in comparison to d or in other words if $\frac{d}{D} = O$ then the lever arm of the force producing bending would be l_1. The above assumption involves a knowledge of some of the conceptions

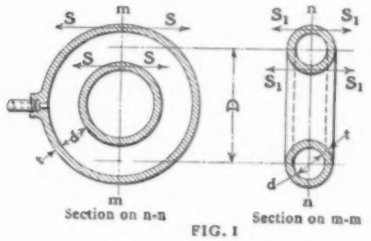


FIG. 1

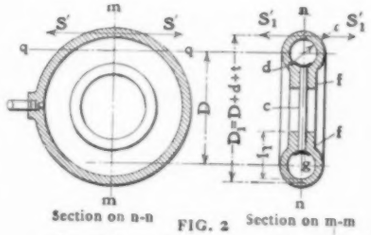


FIG. 2

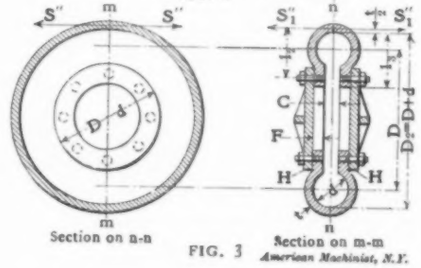


FIG. 3

DIAGRAMS ILLUSTRATING "A PROBLEM IN STRESSES"

peculiar to that branch of mathematics known as the calculus, and since I desire to leave all the calculus derivations to the wise, I will state the case in another form; viz., if this cylindrical ring were not really a ring but a straight tube with the slot in one side then the lever arm of the force producing bending on the section $n\,n$ would be equal to l_1, but since it is not a straight tube but cylindrical in form and the flange f is comparatively stiff we may consider that the bending moment on the section $n\,n$ is that due to a cantilever fixed at the end n, free but guided at the end f with the center of pressure at line $q\,q$ and while this is not quite theoretically correct it should be near enough for practical purposes. For this case the lever arm is $\frac{1}{2} l_1$ and the load being $p \pi D d$ the bending moment is

$$M = \frac{1}{2} l_1 p \pi D d. \quad (6)$$

Now the section modulus of a rectangular section is $1/6\ bt^2$ where b = breadth and t = the thickness of the section. In the case of Fig. 2 $b = \pi D_1$, therefore, the section modulus

$$Z = 1/6\ \pi D_1 t^2, \quad (7)$$

and bending stress

$$S_b = \frac{M}{Z} = \frac{\frac{1}{2} l_1 p \pi D d\ 6}{\pi D_1 t^2} = \frac{3 l_1 p D d}{D_1 t^2}. \quad (8)$$

This stress S_b is tension on the inside of the ring and compression on the outside of the ring so that for the inside fibers we have $S_1' + S_b$ to be combined with S' which latter acts at right angles to S_1' and S_b the resultant becoming

$$S'_2 = \sqrt{S'^2 + (S'_1 + S_b)^2}. \quad (9)$$

We will now further modify the problem by removing the gaskets g and applying in their stead the two heads or covers H as per Fig. 3. The internal pressure tending to bodily separate the two halves on the line $n\,n$ now acts upon the entire diameter D_2 and

$$S''_1 = \frac{\frac{1}{4} \pi D_2^2}{D_1 \pi t} = \frac{p D_2^2}{4 D_1 t}. \quad (10)$$

In a similar manner the internal pressure tending to bodily separate the two halves on the line $m\,m$ now acts upon the entire area embraced within the portion section-lined in section $m\,m$ of Fig. 3. Let A_2 = this area then

$$A_2 = \frac{1}{2} \pi d^2 + C (D - d) + 2 F D_3 \quad (11)$$

Now let A' = area of metal section lined in section $m\,m$ of Fig. 3, then

$$S'' = \frac{p A_2^2}{A'}. \quad (12)$$

For the bending action we may first consider a uniformly distributed load over the area $\frac{1}{4} \pi (D_2^2 - D_3^2)$ and take its center of application as being $\frac{1}{2} l_3$ from the inner edge and its lever arm as $\frac{1}{4} l_3 + \frac{1}{2} t$, since the cantilever is free but guided on the inner end. In addition to this we consider a concentrated load on the ring

acting at the center of the bolt circle; this load is equal to $\frac{1}{4}\ \pi\ D_2^2\ p$ and its lever arm is $\frac{1}{2}\ l_2$ due to cantilever being guided on the free end. The movement is then

$$M_1 = \tfrac{1}{4}\pi\ (D_2^2 - D_3^2)\ p\ (\tfrac{1}{4}\ l_3 + \tfrac{1}{2}\ t) + \tfrac{1}{4}\pi\ D_3^2\ p\ \tfrac{1}{2}\ l_2. \quad (13)$$

The section modulus Z is given by (7) and the stress due to bending is

$$S_b' = \frac{M_1}{Z}. \quad (14)$$

As before the stress S_1'' and the stress S_b' are in the same direction and summate while the stress S''' is at right angles and, therefore, combined by the resolution of forces or by the equation

$$S''_1 = \sqrt{S'''^2 + (S_1'' + S_b')^2}\ . \quad (15)$$

In a similar manner we might add ribs as in the problem as given by Mr. Norman, or insert a stay-bolt or two, or run a shaft through the center or further modify the problem, and each time the solution would be varied somewhat as new conditions were given, which only goes to show that a study of general principles is necessary in order that the designer may intelligently analyze specific conditions of any particular problem.

Philadelphia, Penn. JOHN S. MYERS.

A Remarkable 5500 Horsepower Pelton Wheel

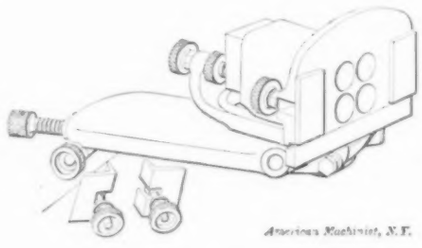
Frank C. Perkins' article, page 720, is misleading, that is, with the exception of the extremely high head used with the wheel. The wheel described does not differ much from a number of wheels used in this country; to my knowledge, there is a unit with an impulse wheel very similar to the one described generating 6000 kilowatts, or 8000 horsepower, and several in different places in the State of California developing 4000 kilowatt, or, approximately 5500 horsepower.

Mr. Perkins' description of the cutting away of the bucket is also misleading, as this principle has been in practice for the last five or six years. In regard to the governor he seems to forget, to hold a water wheel at a certain speed, with a full load thrown on, means stopping instantly the column of water 2200 feet high, or nearly half a mile, and he does not mention what pressure the pipe line would be under in this case. In what governor experience I have had it has been the practice to save the pipe line on the dropping of a load by allowing the increase of as high as 15 per cent. in speed and even then there will be an increase from 10 to 20 per cent. pressure in the pipe line.

Orville, California. J. BEANE.

A Magnetic Work Holder

On page 231 you show a magnetic work holder, by "Thrumy." There is nothing new in this holder, we having manufactured an almost identical one (shown in the cut) for some years. As



A MAGNETIC WORK HOLDER

you have drawn attention to the other holder we will be glad if you will kindly state that a holder as described has been patented and made by us for some years.

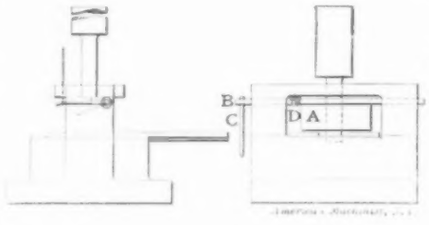
SELIG, SONNENTHAL & Co.

London, England.

Safety Device for a Die

I have noted with interest various safety devices illustrated and described in the AMERICAN MACHINIST and desire to describe one which I applied to several dies with success. Referring to the sketch *A* is a flap fastened to the rod *B*, which passes through the stripper. The pin *C* is fastened in the rod *B* and is attached to the ram of the press, either by a string or wire. When the ram of the press is raised the flap occupies the position shown in the side view. When the ram descends the spring *D* pulls the flap down, striking the operator's fingers and warning him is ample time to withdraw them from the die.

This guard was first placed on the die to help eject the formed pieces, as I was troubled by the pieces falling back into the die, although the press was inclined. This device insured the ejection of the



SAFETY DEVICE FOR A DIE

pieces and prevented accidents so well that it was attached to several dies for its guarding feature only.

A. CALDWELL.

Philadelphia, Penn.

Locating and Drilling Holes

At page 572, W. E. Barnard describes a device for accurately locating and drilling holes, and it brings to my mind an accurate method of locating and drilling holes in work that is either too large for the lathe at hand, or that for other reasons cannot be done in the usual ways. I do not claim to be the originator of this method, but to the best of my knowledge it has not been described in the AMERICAN MACHINIST in recent years, and it may be of value to some of the "young heads" at least.

I was working in an Eastern watch-tool shop where they had under course of construction the experimental model of a computing machine, many of the parts of which were sectors or other odd-shaped pieces of thin metal, with numerous small holes that required great accuracy in locating. This work was accomplished rapidly in the following manner:

There were first prepared a set of "buttons" of the same style as are used for buttoning a job, except that after they were turned and bored nearly to size and hardened, they were caught in a draw-in chuck in a bench lathe, where one end was ground flat, and the hole ground exactly to size with a diamond lap mounted on a grinding attachment, each hole being tested with a plug which was the exact size of the hole in the piece to be machined. A number of each size were prepared in this way, then put on a dead true plug arbor and the outside ground to some standard size and the end ground square with the hole. Screws were made of from 1/32 to 3/64 inch smaller diameter than the buttons they were to fit, and with heads a little smaller than the outside diameter of the buttons.

After the work was laid out and carefully prick-punched, holes were drilled and tapped to take the screws for the respective buttons that were to be used. Then the buttons were screwed down and set by the use of the micrometer, always using, of course, one point from which to work, and then checking up by "double measuring." In this way it was possible to locate the buttons very accurately.

Each button was now carefully soldered to the plate, the screws removed, the work checked up to see that no movement had taken place, and the holes drilled to size with a single-lipped drill, or if greater accuracy was required they were drilled to within 0.0005 inch and then reamed with a single-lipped reamer.

In doing work in this manner it is absolutely necessary to have all drills and reamers the exact size of the finished holes and holes in the buttons; in fact, a gage fit. The hole and outside of button must be concentric, and at least one end must be square with the hole; a drill press must be used whose table is square

with the spindle and otherwise in good working condition.

This method will be found especially applicable to sheet-metal work, and accurate work, where there are not a sufficient number of pieces required to pay for making accurate drilling jigs.

Chicago, Ill. H. M.

Theory and Design of Friction Clutches

Like Mr. Conway (page 254), I "ha' me doots" as to the correctness of the generally accepted theory that friction exists between two bodies when rubbing is absent. Why? The very word friction both in its vulgar interpretation and in its derivation signifies "that which occurs when two bodies rub upon one another" (Latin *frico* = to rub). If its meaning has been enlarged to include the explanation of phenomena, which might be explained by a really descriptive term, then the enlargement is not a happy one.

At the same time one cannot accept Mr. Conway's assertion that adhesion would be the more appropriate word to explain the nature of the force which holds together bodies in contact and prevents them from slipping. Adhesion exists between, say an envelop and its attached postage stamp, between glued, soldered or brazed articles, or between bodies held together by molecular attraction. Doubtless sticking between bodies in contact in every case is partially due to adhesion or molecular attraction, but this is not by any means the main cause.

The physicist contents himself by naming this peculiar attribute of bodies in mutual contact, static friction. But to my mind this combination of words is self-condemnatory, for the word static signifies "in a state of rest," whereas friction implies moving. Hence we have two words in combination, each negativing the other, which as Euclid would say, "is absurd."

Although friction, looking to its derivation and customary use, means "rubbing," the meaning of the word has been enlarged by our scientificness to include "that which prevents one body moving upon another." Until the meanings of words are set by, say an academy of lexicologists, one must perforce accept any strained (should it be stressed?) definition placed upon them.

After all, whatever be our opinion as to the suitability or otherwise of the word, whether we call the peculiar phenomena under discussion friction or static friction, or use Professor Goodman's (I believe) coined word "stiction," our knowledge of the cause and action of the phenomena is now very definite. Given exact data as to the nature of the surfaces and working conditions, there exists no difficulty whatsoever in designing mechanisms, depending upon the mutual contact of surfaces, to meet any requirements.

Up to a certain point Mr. Conway's examination into the forces to be met with in designing a friction clutch are beyond suspicion. This certain point is that arrived at by his conclusion that with a particular construction the frictional force is 330 (pounds, we presume). It is after this well founded assertion that in my opinion Mr. Conway has gone astray; for he now assumes that this frictional force is exactly equivalent to the total pressure upon the surface of the clutch. That this is not so, it is hoped will be made clear. The clutch in question is stated to be 4 inches in diameter, and the speed of rotation for a 1-horsepower clutch is 100 turns per minute. Allowing for a small slippage, the surface speed of the 4-inch clutch is assumed to be 100 feet per minute. To obtain a resistance capable of transmitting 1 horsepower or 33,000 foot-pounds per minute, necessitates the application of a tangential force at this surface of 330 pounds; i.e., 33,000 pounds divided by 100. So far, so good; but the total pressure upon the surfaces needed to produce a tangential force of 330 pounds is now concluded to be equal to the tangential force, or rather that tangential force is one and the same thing as the pressure upon the surfaces.

Assuming a friction angle whose natural tangent is 0.1, or to use more familiar terms, assuming a frictional coefficient of 0.1, the force to be applied radially to the clutch surfaces, in order to produce (or overcome) a tangential frictional resistance of 330 pounds will be 330 pounds × 10 = 3300 pounds; ten times the amount allowed, according to Mr. Conway's method of treatment of the subject. Provision will necessarily require to be made in any actuating mechanism for a ten-times greater leverage at the point of closing than would be called for if Mr. Conway is correct. The only satisfactory method within the knowledge of the writer, and certainly within his experience, is by means of some harmonic or similar motion in which the leverage increases rapidly at the end of the motion. No simple lever motion, no even wedge action is suitable, either of these necessitating a greater arc or span of movement, as the case may be, than is convenient in operation.

The point of heat increasing (when slipping is taking place) as the diameter increase has been admirably commented upon by Mr. Alvord (page 536) and needs no further comment from me except to point out that with the exceedingly low pressure per unit of area in this clutch, there is little danger of seizing or freezing, as Mr. Alvord puts it, unless the surfaces are absolutely dry.

Herewith are given in tabular form particulars of friction clutches of the expanding brake type, in actual successful use; most of them having had years of actual running under ordinary working conditions. In every case the brake rings are cast iron, the internal clutches into which they expand are of the same material, or low-carbon steel (about 0.35 carbon). Pressure is applied in some cases by toggle levers, in other by parabolic spools or wedges in conjunction with angular wedges. Either system, of course, fulfills the idea expressed of a necessity for getting an approximate harmonic motion. In no case is the span of movement more than 15 inches, nor the pressure needed more than can be comfortably applied by one hand.

Case.	Horsepower of Belt.	Maximum Horsepower of Cut.	Revolutions per Minute of Clutch.	Diameter of Clutch, Inches.	Width of Clutch, Inches.	Surface of Clutch, Square Inches.	Surface Speed of Clutch, Feet per Minute.	Tangential Force or Resistance.	Radial Force to Produce R. $F = uR$ $u = 0.1$	Pressure or Surfaces of Clutch in Pounds per Square Inch.
Columns	1	2	3	4	5	6	7	8	9	10
1	8	4	600	3	1	9.5	430	310	3,100	325
2	8	4	300	5	1	16	390	335	3,350	210
3	16	8	400	6	1¼	24	630	420	4,200	180
4	24	12	400	7	1½	28	730	540	5,400	200
5	8	4	30	8½	1½	40	67	1,970	19,700	495
6	8	4	30	9	1¼	35	71	1,860	18,600	525
7	16	8	25	10	1½	47	65	4,000	40,000	850
8	24	12	20	12	1½	57	63	6,300	63,000	1,115
9	..	7½	6	16	1¼	63	25	9,900	99,000	1,570

PROPORTIONS OF FRICTION CLUTCHES.

Column 1 gives the actual horsepower calculated with belt tensed to 60 pounds per inch of width. All mechanism is constructed to carry the whole power in case of a holdup or jam. As a rule, when this occurs the belt slips, although, no doubt, the friction clutches also slip to some extent and so relieve sudden stresses. "Holdups" occur so infrequently that their effect upon the durability of the clutches is negligible.

Column 2 gives the actual power the clutches are expected to transmit without failure, and the figures are such as will not be exceeded under ordinary working conditions. The figures may be looked upon as maxima. The average power transmitted will probably be less than 50 per cent. of this. From careful observation of the condition of clutches after several years' running, I can assert that, without doubt, any of the clutches is

capable of transmitting the full power, as given in column 2, for an indefinitely long period of time.

Columns 8 and 9 serve to give point to the difference between tangential resistance and radial pressure. Column 10 will be of service to the would-be designer, pointing, as it does, to the fad that the amount of surface really necessary to insure durability in a clutch is exceedingly small. At this point it is well to state that the surface of the brake rings is interrupted by serration, or grooves about a quarter of an inch in width cut transversely, in order to allow the lubricant to escape rapidly from and between the surfaces when contact is being made. This is not an absolute necessity, but experiment showed a gain of about 20 per cent. in driving power for the same applied pressure.

It would also be just to point out that in case 9 the clutch fails on very heavy cuts, which are quite within the capacity of the machine otherwise. Attempts made to increase power by increasing leverage have failed, due, it is thought, to the fact that the yield point of the parts has been reached, so that extra pressure applied is lost in expanding or compressing the material. It must be noted that even under these drastic conditions, the clutch surfaces retain their good condition. There is practically no wear.

In conclusion, I unhesitatingly assert that I would not have the slightest hesitation in reducing the diameter of any of the clutches considerably, thus increasing the unit pressure, if, by doing so, difficulty would not be met in getting the higher pressures or leverages necessitated by the departure.

Coventry, England. C. L. UTCHER.

An Exponential Equation

In Volume 31, Part 2, on page 790, Joseph W. Roe gives a very ingenious method for solving a certain kind of equation which, in the title, is called, "An Exponential Equation." This is not an exponential equation, as the term is used among mathematicians, but an ordinary equation with rather formidable looking exponents. However, it may be that among draftsmen and machinists this is what is understood by an exponential equation; if this is so I would like to know it.

An exponential equation is one in which the exponent itself is a variable, thus $H = V^x$ where X is a variable is an exponential equation; the exponent may not necessarily be the only variable.

CHARLES J. HUDSON.

Amherst, Mass.

[The above letter was referred to Professor Roe, and below is his reply.—ED.]

In reply to the point raised by Mr. Hudson, I would say that he is correct in saying that the term exponential equation should be applied, strictly speaking, to those involving a variable exponent. In calculus this is the only form understood. But among engineers and draftsmen the term is very generally extended to include equations having decimal exponents, which are solved by the same methods as those having variable ones. He will find this usage among standard engineering writers. For instance, in connection with this very subject of formulas for the flow of water in pipes, Professor Merriman, in his "Hydraulics," page 261, refers to Lampé's formula as follows:

"The exponential formula deduced by Lampé for clean cast-iron pipes varying in diameter from one to two feet is

$$V = 77.7\, d^{0.691} \left(\frac{h}{l}\right)^{0.555}."$$

It is evident that the method of graphical solution in the article referred to applies to equations with variable exponents, as well as to those having decimal exponents.

JOSEPH W. ROE.

New Haven, Conn.

The Close Corporation

Not long ago an editorial appeared in the AMERICAN MACHINIST pointing out some of the bad features of the so-called "secret-process" policy of so many manufacturers who are afraid to allow any stranger to take a look at their plant and machinery for fear that he will discover some of the ingenious things which the manufacturer thinks are peculiar to his own establishment. An amusing instance of this occurred to me in a small city in central New York a few short weeks ago.

The manufacturing establishment in question is one of a number of independent concerns which are bucking the trust, as they say, and turning out a very familiar product in the making of which there can be but few secrets. In spite of this, however, both the trust which is being bucked and the independent concerns which are doing the bucking are so tight with their information that any stranger found in their plant is liable to arrest on sight for trespass.

Now it happened that my natural curiosity in regard to things mechanical gave me a desire to know something about what was going on inside one of these plants, and, strange to say, I was enabled to obtain from the president of the concern an invitation to come to the plant and enjoy myself thoroughly in looking it over. Much to my surprise when I went to the plant I found that my host, the president, was absent and that he had left strict orders that under no circumstances was I to be allowed to put my nose inside the door, at any rate, beyond the office! However, one of the "influential men" of the company was detailed to give me a brief lecture on the subject of the manufacture of their particular product, which he proceeded to do in all earnestness and with, to him probably, vivid illustrations by means of word pictures and complicated gestures and motions of the hands.

In spite of the efforts of this kind gentleman my imagination could follow him only part way, and finally in desperation this influential man slid me quickly down the back stairs and at the risk of losing his "influence" he did allow me to take a couple of glances inside of one of the mill rooms while he stood careful guard over me to see that I did not get away with any ideas.

As long as I was given this very great privilege of seeing at least the outside edge of the holy of holies I took in as much in a few glances as I possibly could.

The machine nearest me interested me very much, and I could not exactly see the use of some of the rollers and belts which constituted part of its makeup. In great fear that I should be immediately ejected for trying to find out too much, I ventured to ask the influential man whether the material in passing through this particular machine went "straight in between these two rollers and came out between those two or whether it was bent upward and around and over that roller and finally down through those two over there." "Oh! no," said the influential man, "the material goes straight in between these two rollers and comes straight out between those two. It does not go up over that one."

"Well, then," said I, "what's the use of that one? It certainly looks to me as if it must be put there for a purpose."

The influential man took another look and then, seeing the foreman, called out, "Say Bill, does that stuff go straight through between those rollers and out on the other side, or does it go up and around that other roller and finally down out through those two?"

"It goes up and around over the upper rollers," said Bill.

Even this did not convince the influential man but after a careful examination and further explanation on the part of Bill he finally exclaimed, "Well, that's surely one on me. I have been around this plant for five years; thought I knew the business from A to Z, but it is evident I never knew before what those two rollers were really for!"

A few minutes later, as I was being politely shooed out of the front door, I was thinking to myself that perhaps if they would let a few more ignorant strangers come in and take a look at their works once in a while there might be several details about their own business that could be taught in a few minutes to some other influential men of the company.

New York, N. Y. R. S. BAYARD.

Antique Musket and Cannon Manufacture

Herewith are reproduced ten plates illustrating processes of artillery manufacture and other shop operations at the time of the Revolutionary war. They are taken from a French book loaned by Albert E. Guy, chief engineer of the De Laval Steam Turbine Company. It is entitled "Recueil de Planches de l'Encyclopédie"—collection of plates of the encyclopedia—Vol. I, and was published at Paris, 1783.

There is no explanatory text in this volume, except the captions of the illustrations, with the aid of which it will not be difficult to understand the methods of work, some of which are especially interesting because of their resemblance to modern practice.

Plate I shows a duplex machine for boring and reaming musket barrels. Worthy of note is the system of troughs to convey water for cooling the work.

Plate II contains another machine, apparently intended for a similar or allied purpose.

Plates III, IV and V show the methods employed to construct the pattern. An arbor such as is shown by Fig. 1, Plate III, is used to build the pattern on. This is made by taking a round iron bar, somewhat longer than the cannon, squaring it on the end for the hand wheel, shown by Fig. 2, and fastening some tapered strips to it.

On this arbor molder's hay or straw rope is wound, as shown in Figs. 4 and 5, and this is plastered up with a clay dope that fills up all the open spaces. More rope is then wound on to shape up the cannon, as shown in Fig. 1 of Plate IV, and this is again covered over with mud. The arbor with its coating is then revolved beside a sweep to give it its proper shape, as shown in Fig. 4, the sweep being shown by the piece *D D*.

The next operation is to put the trunnions and ornaments on, as shown in Plate V. Figs. 1, 2, 3, 4 and 5 show molds for the ornaments and these are molded on the cannon pattern after it has been swept to its proper shape. Fig. 8 shows a section of the cannon pattern close to the trunnions.

After the pattern is finished the mold is built over it and this is bound up with hoop iron, as shown in Plate VI. Figs. 1, 2 and 3 show the work in different stages, and Fig. 4 shows the completed mold. When the job reached this stage the pattern arbor was drawn out, the rope pulled out and the loam or clay coating broken up and removed; thus a new pattern had to be made for each mold.

The mold was dried, as shown in Plate VII, and the firing end of the cannon was molded and attached to the barrel mold, as shown by Fig. 2, while Fig. 3 shows a sectional view of the mold on the center line, as it is ready to pour, and Fig. 1 shows the runner that was used when pouring.

Plate VIII is a machine for boring and reaming the cannon after casting. As may be noticed, it is driven by horsepower and there is a bucket in the center to catch the chips. Fig. IX, which shows some details of this machine and its tools, is especially interesting because of the inserted-blade reamers.

One other plate has been selected for reproduction. It shows the manufacture of clock chains, with various tools for the purpose. It will be noticed that sprocket chains were in vogue, but they were no novelty even then since they had been made in modern shapes as early as the year 1500.

There is much else in the volume which would be found instructive as to the way of doing things at its period. Skimming it from the beginning to pick out the industries that particularly attract attention, one notices plates of needle making, similar to those reproduced in the AMERICAN MACHINIST, Vol. 30, page 741. There is a series of cuts showing operations at an anchory, which give an idea of the method probably used at the old forges in New Jersey and New York, which, in the eighteenth and first half of the nineteenth centuries were run largely on anchors. Two plates are devoted to the products of the armorer, such as helmets and maces, although at the time the book was published these could not have been in use other than for ceremonial purposes. The craft of making fireworks receives considerable attention, and it is

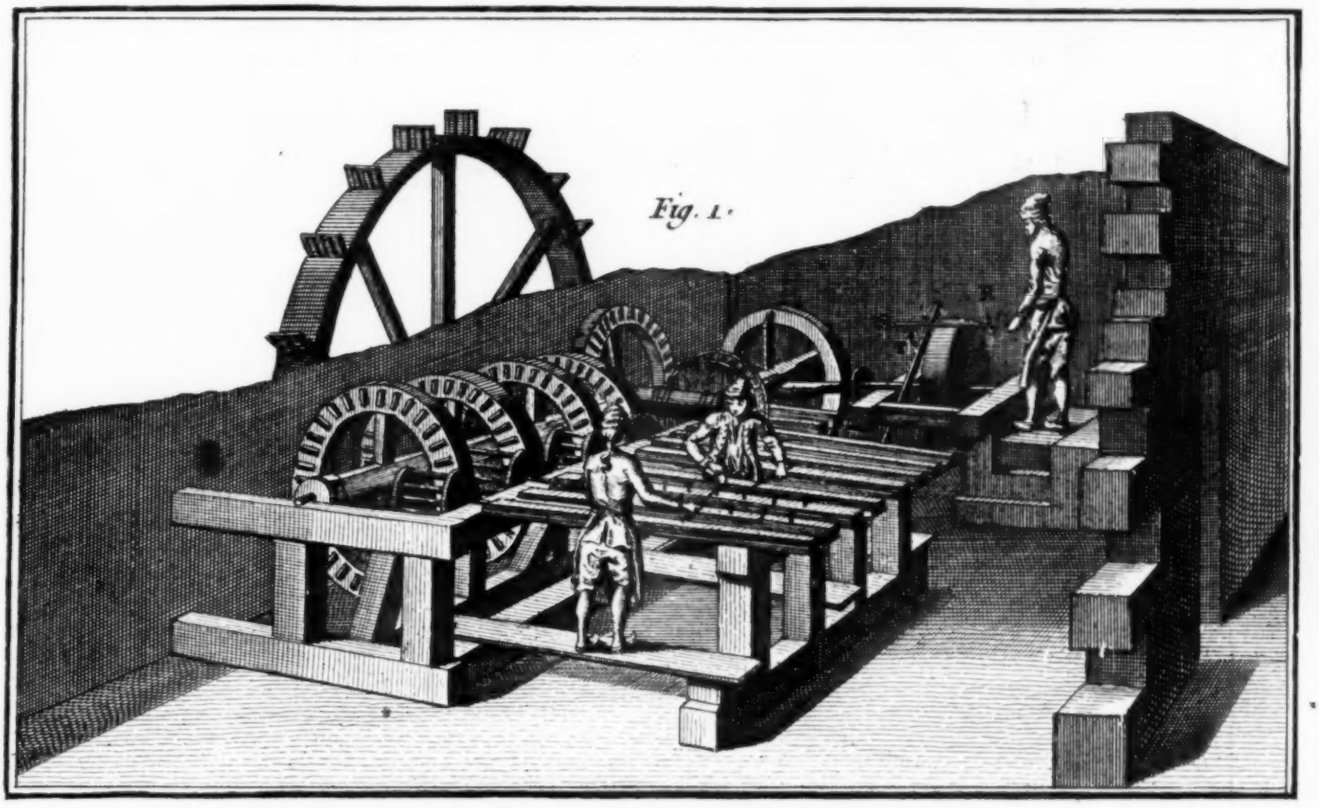


PLATE II. BORING OR OTHERWISE MACHINING MUSKET BARRELS

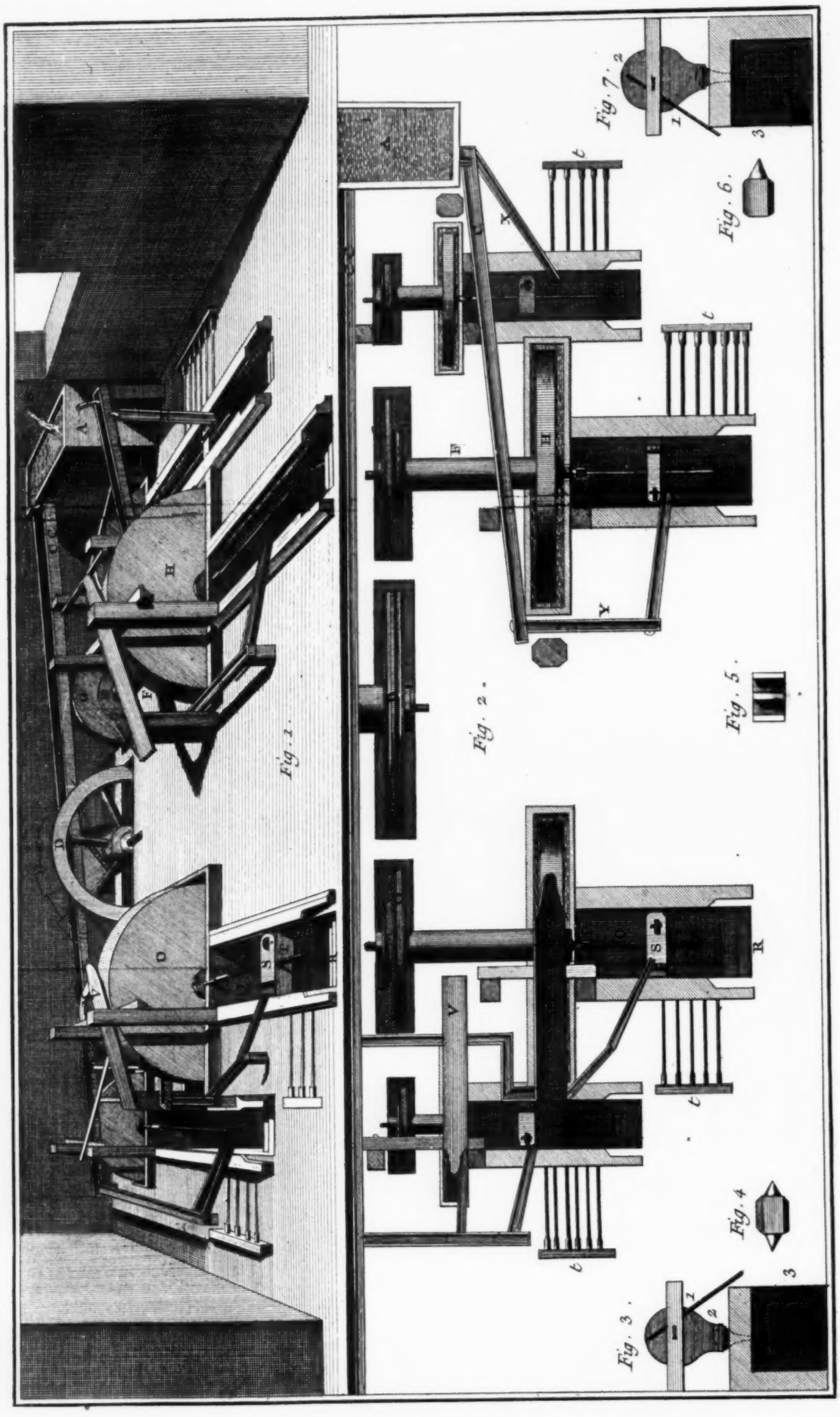


PLATE I. BORING AND REAMING MACHINE FOR MUSKET BARRELS

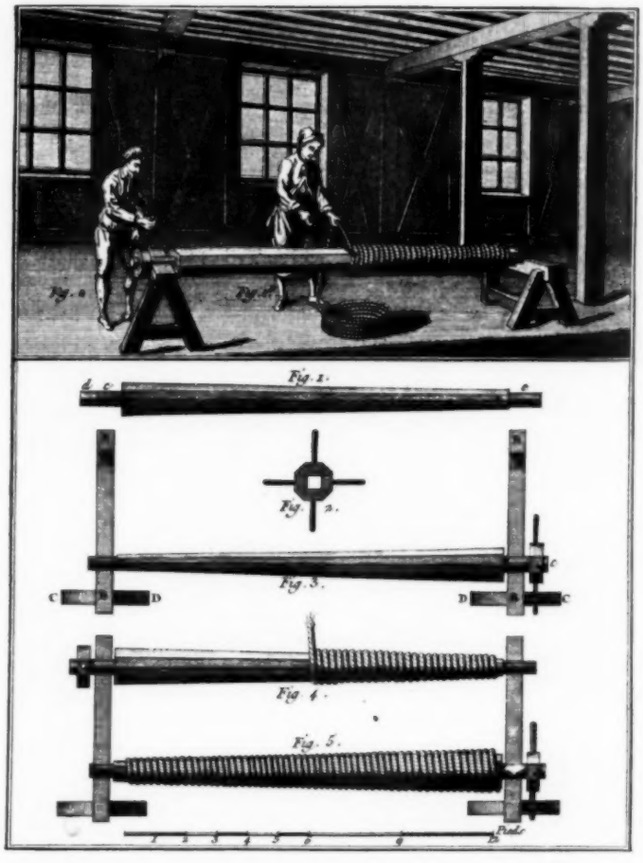


PLATE III. ARBORS AND ROPE WINDING IN STARTING THE CANNON PATTERN

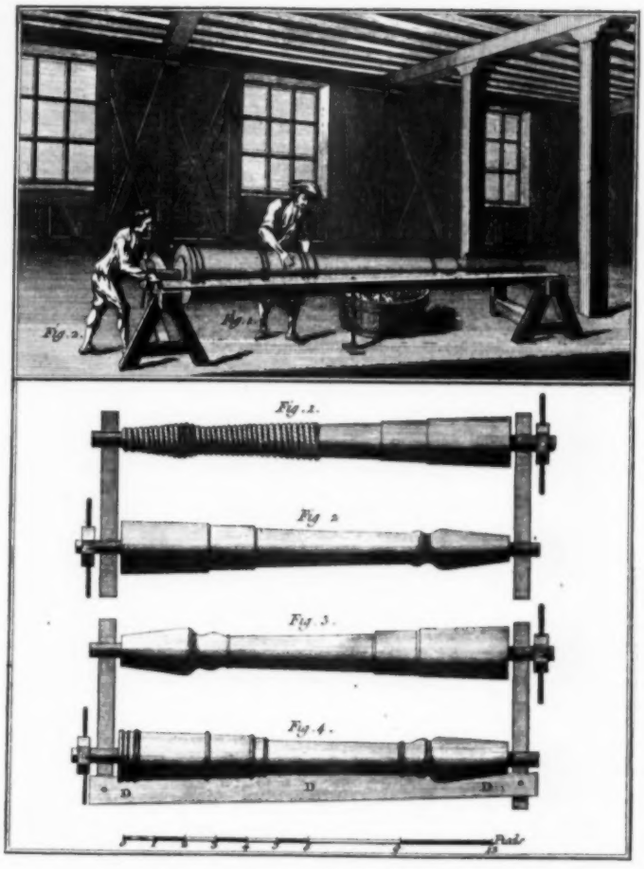


PLATE IV. FORMING LOAM COVERING ON ARBOR FOR THE FINISHED PATTERN

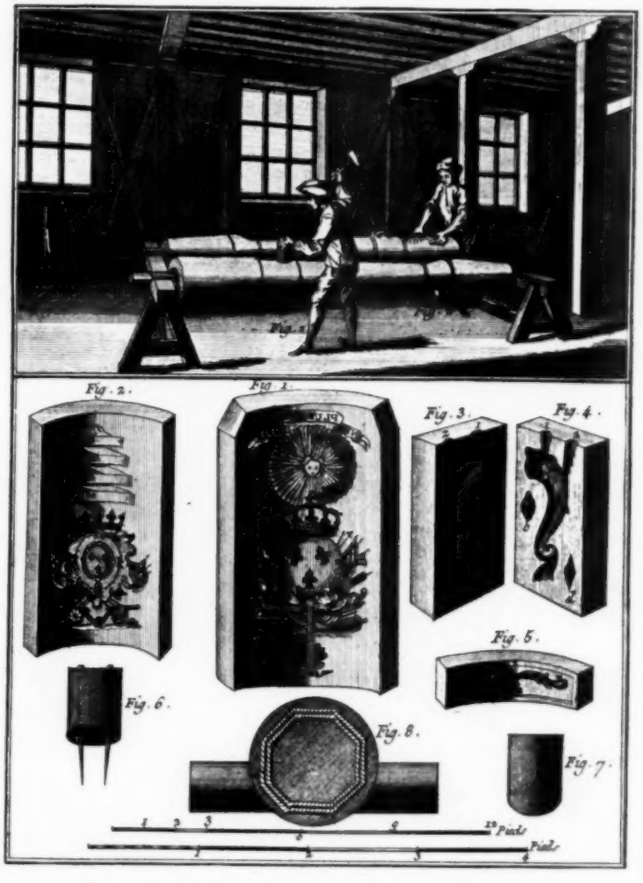


PLATE V. APPLYING TRUNNIONS AND ORNAMENTS

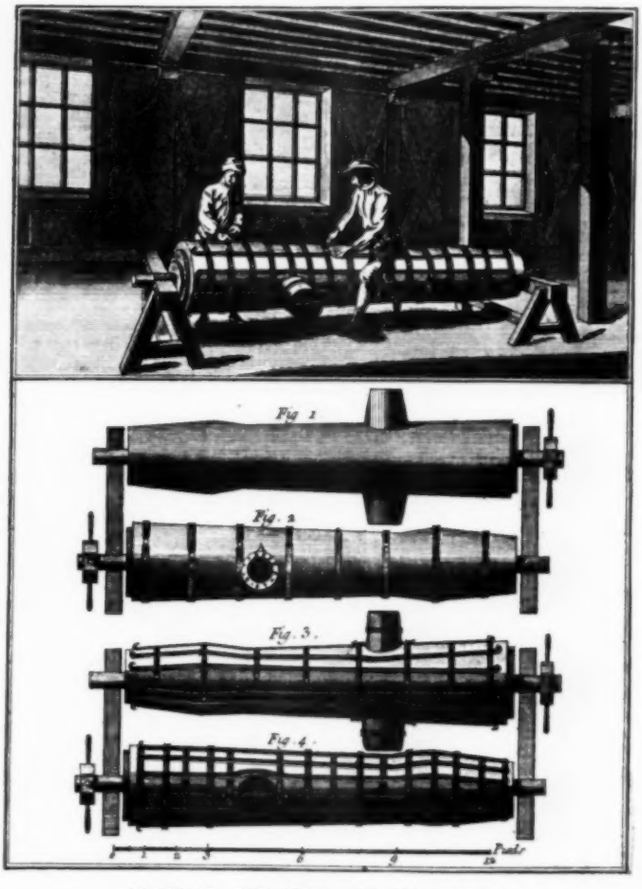


PLATE VI. THE MOLD AND ITS BINDERS

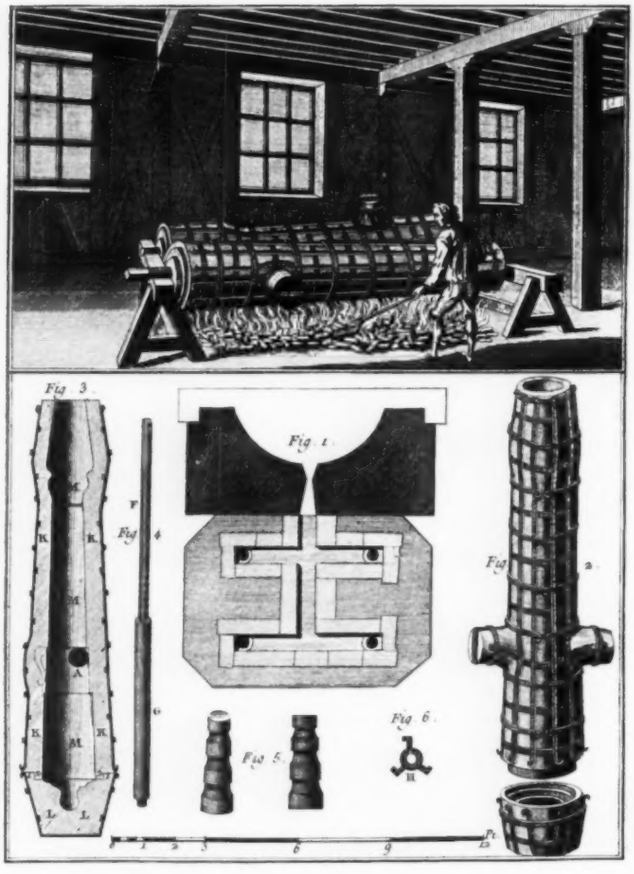


PLATE VII. DRYING THE MOLDS, RUNNERS, ETC.

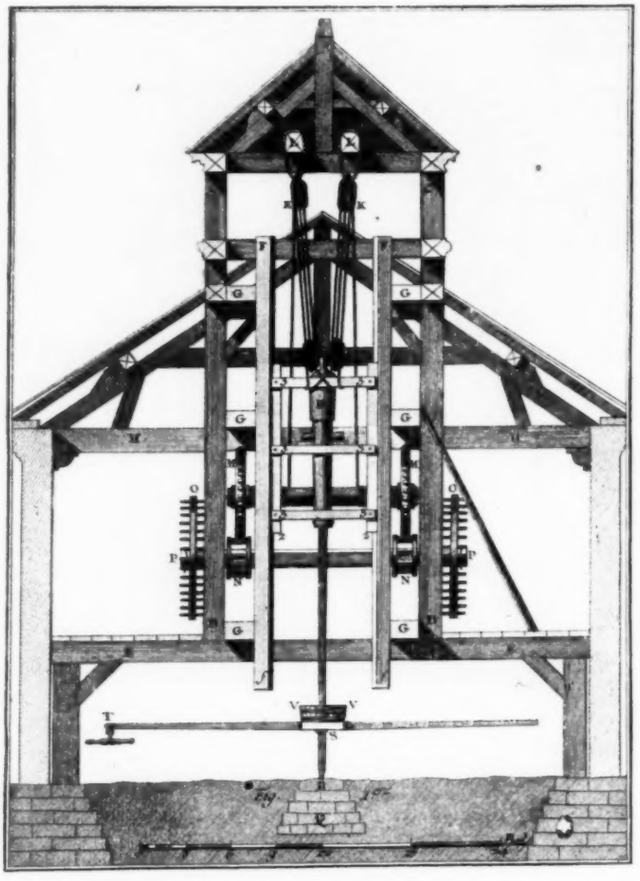


PLATE VIII. MACHINE FOR BORING AND REAMING CANNON

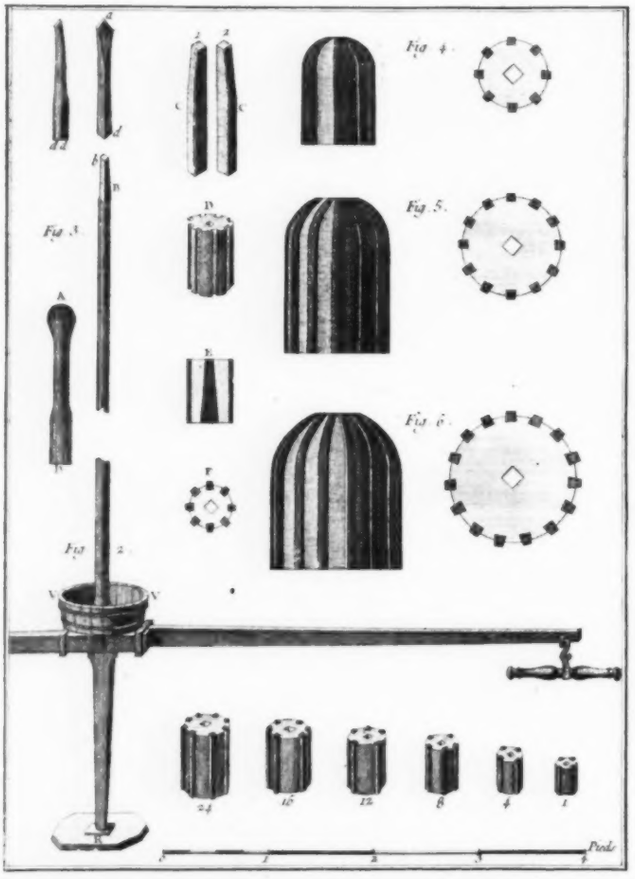


PLATE IX. DRILLS, REAMERS AND DRIVE OF MACHINE IN PLATE VIII

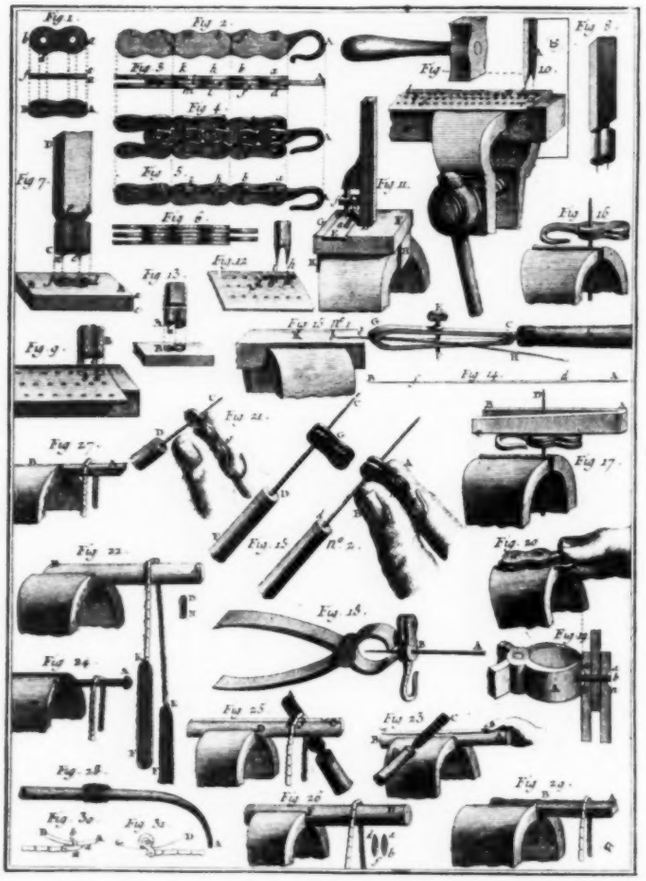


PLATE X. TOOLS AND APPLIANCES FOR MAKING CLOCK CHAINS

evident that rockets, pin-wheels, set figures, etc., were well known.

One of the most complicated pieces of mechanism shown is a stocking-knitting machine, textile machinery being a line in which complication was earliest introduced. The processes of type founding, which are illustrated, appear to be about the same that have prevailed from the earliest up to very nearly the latest times. Candle making, as presented, is hardly a mechanical art, but it wears an air of home-like familiarity for those who can remember the making of tallow dips in American farm houses. Coal-mining operations are shown, as well as those followed in charcoal making. It may not be understood by all that the introduction of mineral coal within the last hundred years applies only to anthracite, bituminous coal having been burned long before.

There is a press for undefined purpose which looks like a modern hay press except that the source of power is a tread wheel. We notice a sawmill with multiple vertical saws, actuated by water power. Another vessel with four paddle wheels and a rope passing over drums is designed for navigation up stream by the power of the stream. Still another boat contains a simple harbor dredge actuated as it would seem, by a large tread wheel in the center.

Finally may be noted plates devoted to wire drawing and to Damascus tooling of gun barrels, etc.

A Scottish Coil Clutch

By Frank C. Perkins

The halftones Figs. 1 and 2 and the line engraving Fig. 3 show a coil clutch, of Scottish design, fitted into a hoisting drum made by the Coil Clutch Company, Ltd., Johnstone, Scotland. The device was installed in a coal-shipping plant in Japan.

Referring to Figs. 2 and 3 the coil is shown of a decreasing sectional area from the driving end to the operating end or from *H* to *T*, Fig. 2. It is of mild steel with an accurately bored and carefully polished interior. The drum upon which the coil grips is of chilled cast iron, also highly polished.

The operating mechanism is a sliding sleeve shown at the right of Fig. 3 and a dog and releasing spring engaging the smaller end of the coil shown in the left-hand view.

The capacity is 48 horsepower at a speed of 3.9 revolutions per minute, with an allowable overload of 50 per cent.

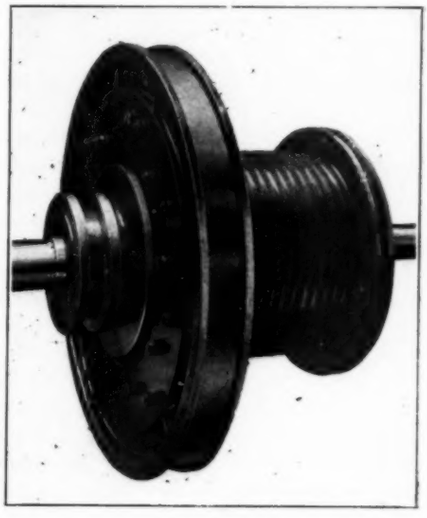


FIG. 1. ROPE DRUM FITTED WITH A COIL CLUTCH

FIG. 2. COIL OF COIL CLUTCH

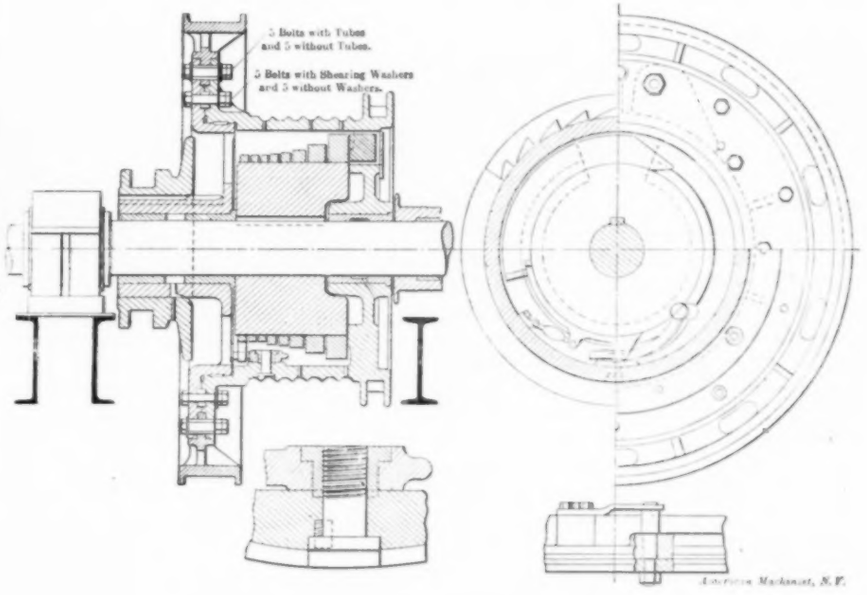


FIG. 3. A SCOTTISH COIL CLUTCH APPLIED TO A HOISTING DRUM—GENERAL ASSEMBLY

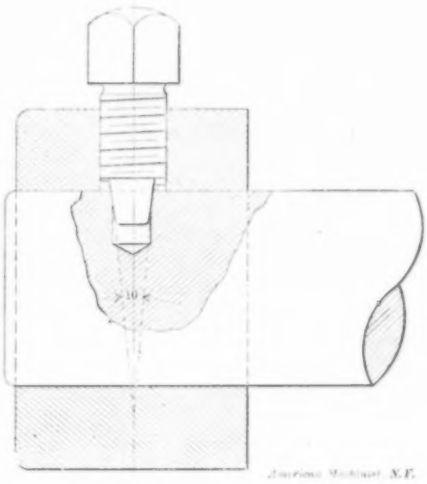
A six horsepower coil clutch of the same design weighs only 3¼ pounds and has a bore of 4 inches.

It is noted in a mineral contemporary that all the marble used on Argentina's new government building at Buenos Ayres will be cut with carborundum wheels made here.

An Effective Set Screw

By Harry Ash

The set screw shown is one which should be used where there is a tendency or chance to jar loose and cause damage. It holds well and does not mar the shaft. The taper of the point being very slight (not over 10 degrees included angle) causes a wedging action which resists the tendency to jar loose due to shocks or vibration.



AN EFFECTIVE SET SCREW

The effectiveness of this screw will warrant the extra expense of having to taper the point and ream a shallow hole to suit. It is obvious that the use of a screw of the kind described in place of an ordinary one might prove the means of saving many dollars and lost time.

Double-throw Pipe Bends

By C. Boysen

When a pipe line changes its direction in two planes at one point, that is, either upward or downward, and at the same time to one side or the other, a pipe bend must be inserted. The angle of this bend must correspond with the two angles necessary for the up- or down-throw and the side-throw; or, in other words, a double-throw pipe bend must be made, which throws the direction of the pipe in such a manner that the change in both directions is properly accomplished.

In laying out the various piping systems for new power houses, industrial plants, etc., the piping engineer, in nearly all cases, can arrange to overcome any variations in the hights of the different pipe lines, or any deviation from a continuous straight line by means of ordinary square bends and offset bend. He is seldom confronted with the problem of designing a bend with a double throw to serve as a connecting piece between pipe lines, located at different elevations, as well as having different horizontal directions.

Double-throw bends, however, have to be inserted occasionally in old plants, where changes of either a necessary or desired nature are made; also in industrial establishments where pipe lines have to be laid for long distances above ground from the central steam-generating plants to the different engines, as, for instance, in mines. In such piping systems the formation of the ground often makes changes in two directions a necessity.

According to my knowledge, no other than the graphic method for ascertaining the angle of a double-throw head is used, and, considering the peculiar nature of such a bend, I have seen hours spent on the solution of such a problem. Furthermore, different designers employ different methods and arrive at different results, so that many mistakes are made. A quick and absolutely correct solution for obtaining the angle of a double-throw bend by means of the graphic method seems still to be a thing of the future. Doubtless there is a correct graphic way to obtain the angle for a double-throw bend, and some engineers know it; but it is not universally known by piping engineers.

For this reason I came to the conclusion that the solving of this problem would best be accomplished by means of a simple formula, and for demonstration, I made a wooden model, as shown in the accompanying illustration, Fig. 2. The angles of the throws are usually known, or can be found, either by means of a transit, or, when space is limited, in the following manner. In Fig. 1 the angle A for the down throw is obtained by stretching two lines, one of which indicating the direction of the pipe to which the double-throw bend has to connect, and the other one leading to the point to which the pipe would have to go for a single throw. These two lines a and b are marked a certain distance from their vertex and the line c is obtained by measurement. The three lines being known the angle for the down throw is found by the following formula:

$$cosine\ A = \frac{a^2 + b^2 - c^2}{2\,a\,b}.$$

The angle for the side throw can be found in a similar manner.

Having obtained both angles, the angle for the double-throw bend is found as follows: Fig. 2 shows a wooden model in which the base plane $A\,B\,C\,D$ and the top plane $E\,F\,G\,H$ are parallel. The two side planes $B\,C\,E\,H$ and $C\,D\,F\,E$ are at

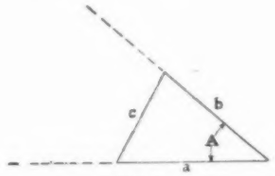


FIG. 1

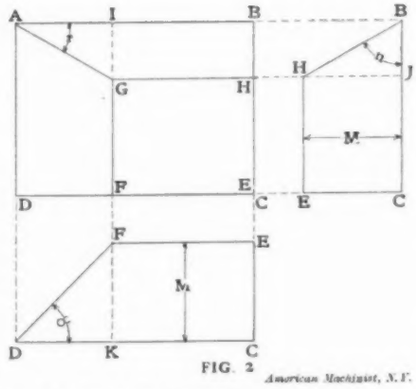


FIG. 2 *American Machinist, N.Y.*

DIAGRAMS ILLUSTRATING ANGLES OF PIPE BENDS

right angles with the top and base planes and also with each other. Angle a is the angle for the down throw and angle n the angle for the side throw. The angle to which a pipe has to be bent is always expressed by giving the supplementary angle. Line $G\,H$ on the top plane indicates the direction of the pipe line to which the double-throw bend must connect, and, to make the double throw, the pipe has to go from point G at the top plane to point A at the bottom plane. This shows that the angle r on the inclined plane $A\,B\,H\,G$, formed by the two lines $G\,A$ and $A\,B$ is the required angle for the double-throw bend.

It would be an easy matter to find this angle if either two of the sides of the triangle $A\,G\,I$ were known, as, for instance, the tangent of the angle r is equal to $G\,I$ divided by $A\,I$, or

$$tangent\ r = \frac{G\,I}{A\,I}.$$

To find these two lines we proceed as follows: $G\,I$ is equal to $H\,B$, and this, again, is equal to $H\,J$ divided by the sine of angle n.

Now $H\,J$ is the perpendicular hight of the solid and is designated by the letter M. Therefore,

$$G\,I = \frac{M}{sine\ n}.$$

Also $A\,I$ is equal to $D\,K$, and this, again, is equal to $F\,K$ divided by the tangent of the angle α. The perpendicular hight of the solid is $F\,K$ designated by the letter M. Therefore,

$$A\,I = \frac{M}{tang.\ \alpha}.$$

Above we have

$$tangent\ r = \frac{G\,I}{A\,I};$$

and, as shown,

$$G\,I = \frac{M}{sine\ n}$$

and

$$A\,I = \frac{M}{tang.\ \alpha}.$$

Therefore,

$$tang.\ r = \frac{M\ tang.\ \alpha}{sine\ n\ M} = \frac{tang.\ \alpha}{sine\ n}.$$

Or in words, the tangent of the angle of a double-throw bend is equal to the tangent of the angle for the down- or up-throw divided by the sine of the angle for the side-throw.

If, for example, the angle r in the model was made for a down-throw angle of $\alpha = 45$ degrees and a side-throw angle $n = 60$ degrees, calculating from above formula we get tangent 45 degrees = 1, sine 60 degrees = 0.86603. Therefore,

$$tang.\ r = \frac{1}{0.86603} = 1.15469;$$

the angle is 49 degrees 6 minutes.

It is obvious that anybody with a slight knowledge of trigonometry can find the angle of a double-throw bend in a few minutes, providing the two angles for up- or down- or side-throw are given.

According to the *Electrical World*, President Eliot, of Harvard, in referring to his promised list of books to occupy three feet of shelf room and the reading of which would impart a liberal education, said that the compilation involves a difficult problem, in the solution of which he fears to make the error of the Bostonian who bought an electrical massage machine. The machine arrived in parts, and the Bostonian could not put it together. Finally he compared the parts with the invoice, and then, in high dudgeon, wired to the manufacturer: "Machine shipped most carelessly: 110 volts missing."

Trade Opportunities in Chile

By M. de Moreira

In no sense can the troubles which have afflicted Chilean commerce be regarded as the natural sequel of any preceding chain of events; on the contrary, the outlook at present is very bright. Like many South American republics, after a lengthy period of political storm and stress Chile has embarked upon a policy of peaceful development, and, notwithstanding a slight financial cloud, the first fruits of that policy are already ripening. The commerce of the country is growing rapidly, established industries are being more fully worked and new ones created, railways are in course of construction, transportation facilities are improving, harbor accommodation and equipment are being increased and everywhere substantial advance is being made.

It seems, however, that manufacturers have been afraid to do business with Chile on account of its little financial trouble, as the total imports in 1908 aggregated only to $97,551,421, some $8,000,000 less than the previous year. On the other hand, their exports to various countries augmented in that year by more than $14,000,000.

It is hard to understand this decrease of imports when one considers that 2829 factories were in operation last January, and that the country is engaged in great improvements which would furnish some of our American manufacturers excellent opportunities.

Railway Construction

Railway construction is progressing rapidly in Chile. As a matter of fact, more than 800 miles of railway are now under construction, necessitating 103 bridges and 17 tunnels which, with the needed machinery and rolling stock will cost the tidy sum of $100,000,000.

A few weeks ago the Chilean government authorized the building of another railway from Arica to La Paz, which will cost $15,000,000. This railway will also require a great amount of tunnel work, and American machinery for that purpose will certainly be welcomed; moreover, the government of Chile will need 3000 tons of steel rails.

The greatest tunnel now under construction in Chile is the trans-Andean tunnel, which will connect the Argentine and Chilean railways. The machinery used is mostly English, for the reason advanced previously that the English people go after the trade more energetically than American manufacturers or contractors.

Water Communication

Nor is the Chilean government occupying itself solely with railways, water communication also playing a great part in the progress of the country. The Chilean mercantile marine exceeds at present that of any South American republic—Brazil excepted—being of 156,316 tons, out of which 107,724 tons are steam. All these steamers have been built in Chilean yards, and there must be a demand for appropriate machinery for the construction of steamers, engines, and also tools for the various repair shops along the coast. In the shipyards of Valparaiso six steamers and 50 launches are now being built. All these require machinery, boilers, etc., which can be imported from here as well as from England.

The government has also decided to improve the port of Talcahuano and will expend over $300,000 for that purpose. Talcahuano being near the native supply of coal and also one of the safest ports, will become, after these improvements and the construction of a long drydock, the principal Chilean naval station and the business rival of Valparaiso.

Mining Machinery

Mining machinery is, of course, always in demand in Chile. Mining energies have been directed chiefly to copper, the production of which for 1908 is stated as 35,000 tons of refined metal, as against 28,000 tons the previous year. The mines of Teniente are the only ones worked with modern machinery. The exploitation of certain lower grade deposits creates great activity, and calls for uptodate implements. All the copper-mining districts are connected by rail with the nearest port, thus affording every means of transportation and communication. Nitrate, borate and sulphur production are carried on quite extensively in Chile and drilling and general mining machinery of all kinds will find a good market there. Coal-mining machinery could also be included in the list, though the production of coal, 900,000 tons, is only one-third of the consumption of the country, the other two-thirds being imported from England and Australia.

Five hundred miles from Valparaiso are petroleum wells which have reached a depth of over 1000 feet. American boring machines are superior to those manufactured in Europe, but still we do very little to secure this trade. Our neglect is such that even machinery which enters free of duty, such as mining and printing machinery, both of which Chile is much in need of, are neglected for the benefit of England and Germany.

Material for cement manufacture exists a few miles only from Valparaiso, and can be produced very cheaply. An extensive plant has been constructed having an output of 200,000 barrels per annum. Nearly all the machinery comes from Denmark, although I understand that the owner wanted American machinery but had to wait too long for catalogs, etc., and, therefore, turned to another quarter.

Sugar Machinery

Two sugar refineries only are operated in Chile with uptodate machinery, but the small sugar refiners would certainly benefit a great deal if they knew more of the machinery in actual usage in our refineries. The field, however, is small.

The lumber industry in the far south of Chile is also worth the special attention of firms supplying portable steam engines and sawmills. Lumber companies have been organized recently, and the exploitation of the beautiful lumber of upper Chile will begin soon.

A Steamship Line to Panama

The Chilean government recognizes that the country must have quick means of transportation. To this end a steamship line from Valparaiso to Panama, a journey of 12 days, with connection with the line of steamers from Panama to New York, a six days' trip, has been established, making thus a voyage from Valparaiso to New York of 18 days' duration only. This line will start October 1 and should greatly assist manufacturers in pushing their trade in that republic.

The Old Subject of Packing

It seems necessary, however, to remind manufacturers that it is not sufficient to obtain orders and to fill them. They must also, if they wish to avoid trouble, pack their goods properly, although I feel that it is useless for me to say this, as the manufacturer invariably replies that he has made a special study of export packing, and, therefore, knows that his packing is good, though generally it is very poor. As a rule the shippers do not take into consideration the gage of the railway on which their goods must travel, nor the fact that having no docks in Chile, the merchandise is taken ashore in lighters, and that the transshipment from steamer to lighter on a rough sea is dangerous for goods which are not extremely well packed as, for example, those which are inclosed in soft pine cases.

The Chileans have been for a long time sympathetic to English trade, but since the United States has entered in the field of exports I find among the Chilean merchants a widening interest in machinery of American make. If the Americans, therefore, neglect the existing opportunities to push the sale of their products in Chile, no competent observer of the trend of events can doubt that they will regret it later, for whatever financial crisis may arise, such as that from which the country is just now emerging, the requirements of the market must continue to expand. Important as the progress of the last few decades has been, Chile is a country with a still greater commercial future.

According to *Stahl und Eisen*, a series of tests conducted at the Institute for Testing Materials, at Darmstadt, have shown that the tensile strength of nickel-steel rivets is two to two and a half times as great as that of ordinary rivets.

AMERICAN MACHINIST

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June 10	19,000
June 17	19,250
June 24	19,000

This paper reaches 34,000 *separate readers each month and* 19,250 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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The Wright Brothers and the Patent Laws

The recent presentation by President Taft of the medals of the Aëro Club of America to the Wright brothers has brought out numerous expressions of approval of this well merited honor by the press, together with expressions of a feeling that we have too little of this sort of thing in this country. It is undoubtedly true that American inventors receive too little public recognition of their achievements, and the case of the Wright brothers is by no means the only one in which our public authorities have been fairly shamed into giving belated recognition to achievements after their recognition abroad.

The American press, however, is about the last party that has the right to pose as a critic in the case of the Wright brothers. It is, of course, true, that their early successful work was duly reported in the news columns of the daily papers, but if there was any editorial recognition of the fact that here was one of the greatest achievements of man since the dawn of civilization we failed to see it.

Our own editorial, on page 466 of Part 2 of last year's volume, in which we said that "the Wright brothers have accomplished the greatest piece of mechanical work ever done by mortal man" is the only adequate early recognition of which we have knowledge of a fact which is now becoming universally recognized.

At the same time it is not medals, honors, nor official recognition that the American inventor most needs. What he wants is the effective carrying out of the constitutional provision for patent protection of his inventions, a provision which is today practically nullified by the inefficiency of the patent office and especially by the absurd legal procedure which surrounds patent litigation through which the whole patent system has become little more than a farce.

The Wright brothers' patents have yet to pass the ordeal of the courts. The brothers have yet to experience the pocket-exhausting and soul-harrassing experience of prosecuting infringers through the hopeless tangle of complexities and absurdities that go with it, and unless all experience is at fault they are yet to have their achievements cut down to the vanishing point, and to have some former failure dug out of the forgotten past as a sufficient anticipation of their work to set their patents aside.

The Wright brothers no doubt think they know the full meaning of the words anxiety and suspense through their experiences in developing their aëroplane. We very much fear, however, that what they have learned is but the beginning of what they have to learn at the hands of infringers, lawyers and courts.

It is characteristic of the American people that they allow abuses to run on far beyond the point where they become intolerable, a striking case of injustice being needed to arouse attention to long standing abuses. It is by no means impossible that the Wright brothers' aëroplane may supply just this case. Judging from the past, we have very little hope that they will ever see justice when their patents reach the stage of litigation, and should, through their experience, a reform in our patent system follow, they will have accomplished something fairly comparable with their mechanical triumph.

It is nothing less than mournful to contemplate such a possibility, but we shall see what we shall see.

Experimental Development of Machine Tools

In many lines of machinery building the rational and historic method of development has been the experimental. A machine was desired to perform certain functions, or to enter a certain field. It was designed as carefully as possible; built, and then sent out to service. Faults of operation, inconveniences of manipulation, structural weaknesses, improper adaptations were at once apparent if they existed. Changes and improvements were frequently worked out while the machine was thus undergoing a shop test. After a period of several months during which the users and operators, on the one hand, coöperated with the designers and builders, on the other, the crudities and insufficiencies of the machine were usually eliminated and conditions were favorable to the design of an improved machine for the same work. With the second design, this same constructive process of elimination may have been continued and it may have been even carried out to the third or fourth design before the type of machine was firmly fixed, accepted by the trade and on a manufacturing basis.

The usual evolution of the new machine tool is different. It is proposed to build a new tool, say, a lathe or milling machine. The shop that designs and builds machine tools also uses machine tools; therefore, of necessity, the designers and builders in that shop must know what a machine tool should be and should do. Therefore, the machine tool is designed outright, with suitable references to competitors' trade catalogs, and is finally launched on the market. If some of the customers who first select this type complain about details of construction, point out changes which would aid in manipulation and effectiveness, or indicate structural weaknesses, their objections and suggestions are thrust aside with the thought, "We build machine tools and use machine tools and know as much about machine tools as the fellow who is building looms, or sewing machines, or automobiles."

This is the hereditary machine-tool designer's attitude. That this is changing among progressive firms is a cause for congratulation. We can mention several well known, standard machine tools of today, machines outside of the automatic class, that have had an experimental development similar to that which we have sketched in the opening paragraph. The best talent and knowledge of the designer, the best skill of the manufacturing force were put into the first model of the type. The original machines, possibly several of the first type, were sent into representative factories with the request that they be closely watched, and that suggestions be returned which would aid in improving either the machine itself, its manipulation or its product. All of these criticisms and suggestions were then carefully weighed and such as were sound and expedient were embodied in a second design. In this way a final type of machine was produced, which in several cases that we now have in mind, is nearly the acme of development; at any rate, they are machine tools that are hard to beat. The process of constructive elimination has done its work well.

Such a method of machine-tool development is to be commended. "In union there is strength;" "two heads are better than one;" "the united efforts of many are more availing than the might efforts of a few." It is a method of coöperation in which the user and producer unite to develop a product which shall be best adapted for a wide field. It recognizes that machine-shop operations in lines of manufacture other than machine tools may be a far different proposition than machine tool-shop practice. Let us give more attention to the constructive, experimental development of machine tools.

New Publications

How to Use Slide Rules. By D. Petri-Palmedo. 65 4¼x7-inch pages, 33 illustrations. Kolesch & Co., New York City. Price, 50 cents.

The revision in this second edition consists in the amplification of the chapter on the Triplex slide rule, and the addition of two chapters, one on the Nestler precision rule, the other on the Stadia slide rule. These three chapters cover useful and convenient modifications of the Mannheim rule; modifications that deserve to be better known.

Westinghouse E—T—Air Brake Instruction Book. By W. W. Wood, 236 5x7-inch pages; 48 diagrams and illustrations; indexed. The Norman W. Henley Publishing Company, New York City. Price $2.

The development of heavy and high-speed trains has created a demand for locomotive air-brakes particularly adapted for their requirements. Such a type is the Westinghouse E—T (engine tender) equipment of which there are two styles, No. 5 and No. 6. This book gives a description of the device, its method of operation and a set of questions and answers for the benefit of those who wish to qualify for examination on the equipment. The illustrations are the striking feature of the book. They are printed in colors, each color representing a zone of air pressure. Needless to say the tracing out of connections and analysis of mechanical actions are thus greatly simplified. The work is written on the No. 6 style with references to the No. 5 style where that differs. It is written as a text book, thus it is for the man who wishes to gain a thorough knowledge of the equipment and, perhaps, cannot reach an instruction car; for the man who does receive such instruction but wishes a manual as well, and for the man qualifying for examination.

Nicholson on Factory Organization and Costs. By J. Lee Nicholson. 410 8x11-inch pages; many forms and a few illustrations; indexed. Kohl Technical Publishing Company, New York. Price, $12.50.

Whether or not this ambitious work should be commended or condemned depends upon the views and viewpoint of the person expressing an opinion. If that person likes printed forms and prefers to copy such with only superficial changes, the 387 forms in this book may be of interest. On the other hand, if that person believes that it is better to grasp fundamental principles and from them work out forms and blanks suited to specific needs, he will not find the book worth the price. The reviewer confesses that he is in the latter position. The first 57 pages treat in a brief manner of cost finding and accounting, wage systems and distribution of indirect expenses. This is the most valuable part of the book. Pages 58 to 344, inclusive, deal with forms. It is doubtful if these can be of much value to the designer or introducer of a shop system. The difficulty of adapting a given form to existing conditions is admitted by the author in this sentence appearing on page 64. "No one form is adaptable to all lines of manufacture or accounting, and even in the same line of business the same form cannot be used successfully in every instance, as the volume of business, conditions of manufacture, and the policy of the management, so far as the plan of organization is involved, would make this inpractical." The last broad divisions of the book, pages 345 to 404, inclusive, illustrates and describes mechanical office devices; computing machines, typewriters, time clocks, etc. There is absolutely no excuse for dragging such descriptions of manufactured devices into the text of a technical book. The manufacturers of the appliances are well able to advertise their own wares. As a product of the bookmakers' art the work is excellent. It is printed on superfine calendered paper, from clear type and is bound in three-quarters morocco.

Personals*

E. W. McKeen, for many years connected with the mechanical department of the Union Twist Drill Company, has been appointed manager of his company's New York office, located at 54 Warren street.

H. E. Curtis, inventor and designer for the National Cash Register Company, has accepted a position with James B. Hammond, the typewriter inventor. His chief duty will be in developing new inventions.

J. R. Bibbins, publicity engineer with the Westinghouse Machine Company, has resigned his position to become associated with B. J. Arnold, director of appraisers of the Public Service Commission of New York.

Harold A. Richmond, president of the American Emery Wheel Company, sailed on June 17 for a European business trip, which will include visits to his company's agencies in Berlin, Vienna, Paris and Copenhagen.

G. B. Fletcher, secretary and treasurer of the Grant-Hoover Ball Company, is making an extended trip through Europe, combining business and pleasure. Mr. Fletcher expects to return the latter part of September.

M. B. Huff, power engineer, formerly connected with the Philadelphia Electric and United Electric companies, has been appointed general sales agent of the Garwood Electric Company, with offices at Garwood, N. J.

Dr. Harold Pender has been appointed to the professorship of theoretical and applied electricity, which is connected with the department of electrical engineering at the Massachusetts Institute of Technology. Dr. Pender has been engaged in regular engineering practice, as well as being employed by the Westinghouse Electric and Manufacturing Company.

The Worcester Trade School

The trade school which has been under discussion so long for the City of Worcester, Mass.—the first to be organized under the general Massachusetts law authorizing such schools as part of the public-school system, is now an assured thing. The city government of Worcester has authorized the expenditure of $125,000 for the establishment of the school.

*Items for this column are solicited.

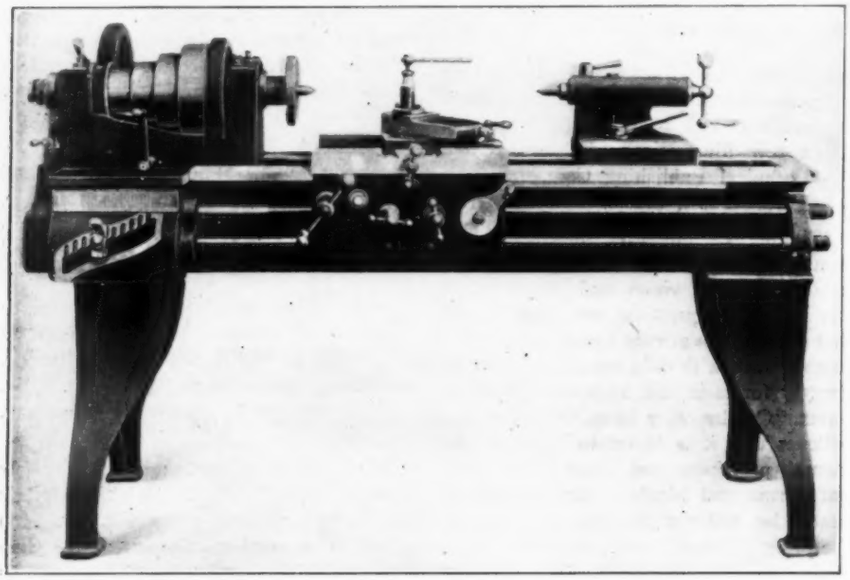
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

14-inch Engine Lathe with Gear Box

The halftone illustrates clearly the principal features of an engine lathe built by the W. P. Davis Machine Company, Rochester, N. Y. This lathe is equipped with a quick-change gear box, which permits a change from one feed or thread to another instantly. The 30 changes possible give a range of from 3 to 30 threads per inch. Special or fractional threads may be cut by changing gears at the end. The spindle runs in phosphor-bronze boxes, has a 1 1/16-inch hole clear through and is driven by a four-step cone pulley taking a 2¼-inch belt. The tailstock is offset to allow the compound rest to be swung parallel to the bed and is provided with set-over for turning tapers. The compound rest is graduated in degrees. The carriage has a deep bridge, a bearing of 19 inches on the ways, and is securely gibbed to the bed. The cross-feed screw has a collar graduated to read to thousandths of an inch. When required the lathe is equipped with taper attachment, oil can and pump; and a plain gib or rise-and-fall rest can be substituted for the compound rest. The lathe shown with 6-foot bed swings 37 inches between centers. The swing over the carriage is 9½ inches and over the ways 15 inches. The cone diameters range from 4⅛ to 9 inches, the back-gear ratio is 10 to 1. The net weight of the lathe is 1600 pounds.



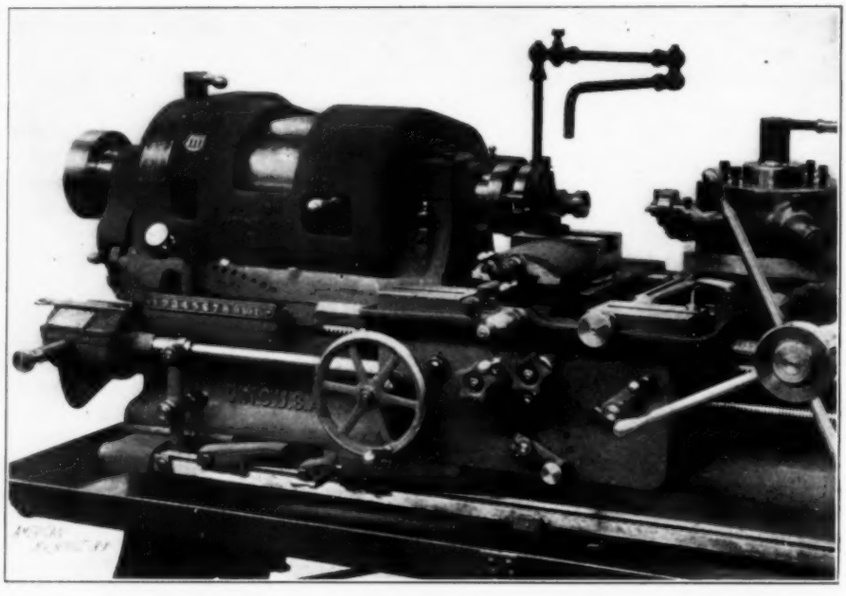
14-INCH LATHE WITH GEAR BOX

Lathe Equipped for Machining Automobile Hubs

This equipment has been designed by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, for making front and rear automobile hubs of malleable iron. The front hubs handled with this special equipment are 5⅛ inches in length, 5½ inches in diameter across the flange, and 2½ inches in diameter on the smaller end which is threaded. The rear hubs are similar, the main difference being that the rear hub is faced on both ends, finished more completely on the outside, and has a ball race at one end only.

The lathe furnished is a Lodge & Shipley 18-inch by 8-foot, patent-head, quick-change-gear engine lathe, with a turret on the bed, which is revolved automatically and provided with power feed. Automatic stops are provided for the longitudinal travel of the carriage, and these stops are adjustable to different positions along the bar shown at the bottom of the bed. The diameter gage, which is clearly shown in the halftone consists of a slotted drum carrying adjustable stops that control different positions for the cross travel of the compound rest. The lathe is provided with special reamers and boring jigs, and a 15-inch combination chuck for the first operations.

In machining the front hub, in the first operation, the hub is held with the flange against the jaws of the chuck. The turret operations comprise: (a) boring a straight hole through the hub with a four-lip drill, (b) boring the seat of the ball cup, (c) reaming the seat of the ball cup. While these turret operations are being carried on, the tool on the compound rest faces the end, thus completing the first operation. The holes in the flanges are drilled before the second operation. Drivers, special arbors for finishing the hubs on the bore and thus insuring a true piece of work, and the turret-tool equipment, shown in place in the illustra-



LATHE EQUIPPED FOR MACHINING AUTOMOBILE HUBS

tion, comprise the equipment for the second operation.

For the second operation, the front hub is mounted upon an expanding straight mandrel, carried in the hole in the lathe spindle. The drive is by a pin, fitted into a drilled hole in the flange. The turret operations comprise boring the seat for the ball cup, and reaming the seat for the ball cup; correct depth is positively obtained. While the turret tools are employed on these operations, the tool in the compound rest faces the flange. The barrel of the hub is also turned and the various diameters are correctly obtained by means of the diameter gage. The thread is then cut with a die, thus completing the machine work for the front hub.

The rear hub for the first operation is held with its flange against the jaws of the chuck. The turret operations are (a) bore, (b) ream the seat for the ball cup, (c) face the seat for the dust washer. While these turret operations are in progress, the compound-rest tool faces the brake pan on the flange, and turns the flange diameter, all diameters and lengths being obtained from the positive stops. The holes in the flanges are drilled before the second operation. In this operation the rear hub is mounted upon a straight arbor, located in the lathe spindle, and as in the case of the front hub the hub is driven by a pin through a drilled hole in the flange. The hub is additionally supported by a bar carried in one of the turret holes, which allows faster cutting, and results in truer work. All operations are performed by the tool in the compound rest and comprise facing the end, facing the flange and drilling the hub.

The Peerless V Belt

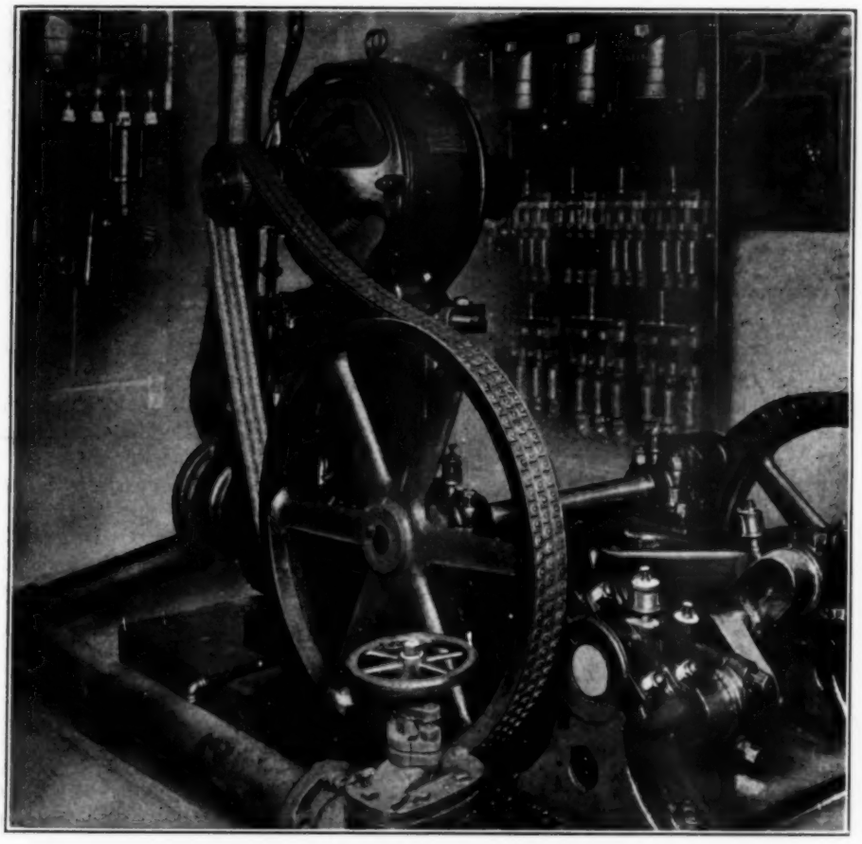
This is a combination of a metal chain with a V-shaped link and a rawhide covering for these links, running in a pulley grooved to correspond, as can be seen in the illustration.

The rawhide gives a high coefficient of friction, is not affected by dampness and not being subjected to strain in this case, has a long life.

The chain itself is carefully made to insure long wear, although this would not be as disastrous as in the case of chains used on sprocket wheels as there is no pitch to be maintained.

The weight of the belt gives it a good arc of contact with a reasonable center distance and the wedging action gives a high coefficient of friction. The small sized belt, 7/8 inch across the top, is calculated to transmit 1 horsepower for each 200 feet of lineal contact per minute, while in the larger size, 1¼ inch, only 130 feet is necessary. Higher powers are transmitted by adding as many belts as necessary.

It is easily lubricated, runs very quietly, and speeds of 3000 to 5000 feet are easily obtainable. It is made by the Peerless V-Belt Company, 215 South Clinton street, Chicago, Ill.



DRIVING WITH A PEERLESS V BELT

Surface and Tool Grinder

Perhaps the most striking feature of this grinder is the hight of the spindle and table, the former being 51 inches from the floor, and bringing the work up so high that the operator does not have to stoop to watch his work.

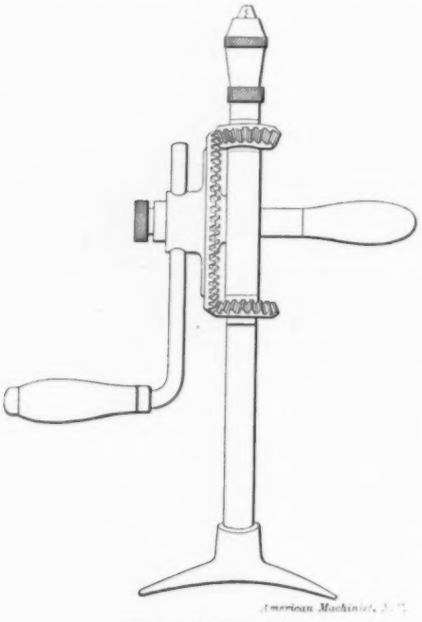
SURFACE AND TOOL GRINDER

It was designed by John J. Grant especially for grinding screw-machine and other tools requiring a surface parallel, or can be used as a surface grinder for pieces of small dimensions. The back end of the spindle carries a wheel for general tool and drill grinding, fitted with a separate test. Two separate tool cabinets are provided in the tall column.

The traverse of table is 6 inches, the cross-movement 3 inches and the vertical adjustment 4 inches. All handles are within easy reach of the operator. The grinder is made by the XX Century Tool Company, 1289 Marquette road, Cleveland, Ohio.

A Breast Drill for Oval Shanked Drills

The line cut shows a new breast drill, which is being put on the market by the Lancaster Machine and Knife Works, Lancaster, N. Y. The spindle is provided with an oval-taper socket to fit the oval-tapershanked drills made by the Whitman & Barnes Manufacturing Company, Akron, Ohio, for the Lancaster Machine and Knife Works. The drill can also be had fitted with a two-jawed chuck.

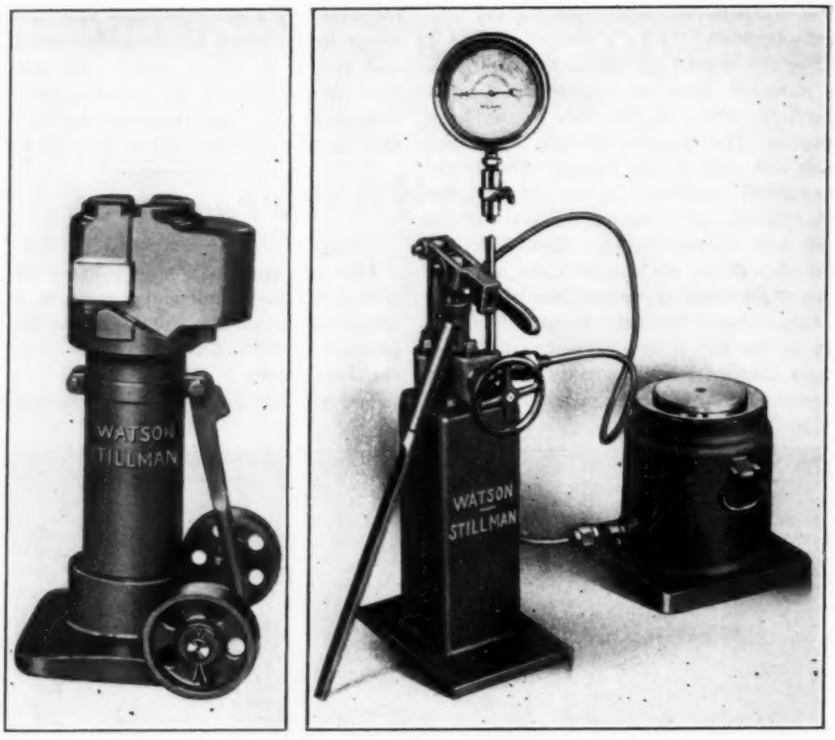


NEW BREAST DRILL

Two Convenient Jacks

We have carried jacks around the shop so long and so often that we have neglected the very obvious convenience of putting a pair of wheels on near the base, as shown in Fig. 1. These clear the floor except where the jack is tipped over to bring them down for moving from place to place, while to use at an angle the jack is simply tipped in the opposite direction. The head is enlarged so that a lack of filling will not stop its working, even with a slight leakage. This is made in 11 sizes, from 20 to 50 tons capacity, and lifts from 12 to 18 inches.

Fig. 2 shows a "two-unit" jack in which the pump and the lifting jack are separate but connected by flexible copper tubing. This is for use in places where a jack is required that is lower than is convenient to use in connection with a pump. So the jack is made to suit conditions and the pump located at a convenient hight and place, as shown. This type ranges from 2 to 1200 tons capacity, and the jack movements of 4 to 8 inches. They are made by the Watson-Stillman Company, New York.



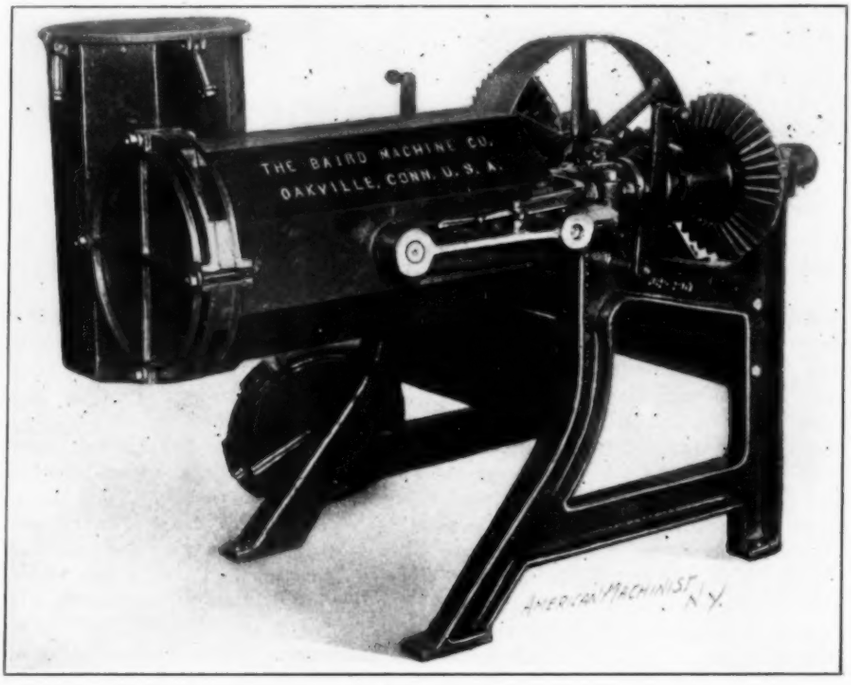
TWO CONVENIENT JACKS

Tumbling Barrels for Finishing Work

The problem of finishing small pieces of work can often be solved by the use of a properly constructed tumbling barrel adapted for the purpose. The one shown herewith is the latest design of the Baird Machine Company, Oakville, Conn., who are specialists along this line.

The machine is made in parts, each barrel having a clutch to throw it in or out of action at will. The barrels are held in a yoke and can be tipped upright for loading or tipped down for dumping the contents after being tumbled.

They are lined with hardwood, includ-



TUMBLING BARREL FOR FINISHING WORK

ing the cover, so that nothing can mar the work. They can be run wet or dry, and are generally used with steel balls as the polishing or burnishing agent, although special cases may require different treatment.

A 22½-inch Heavy Duty Gang Drill

The three-spindle heavy-duty drill press, shown in Fig. 1, has recently been brought out by the W. F. & John Barnes Company, Rockford, Ill. With the 4-step cones illustrated, this machine has the driving power of the average drill press of 34 inches swing. When so desired the machine can be equipped with 3-step cones for 4¾-inch belt, and when thus fitted the machine will drive a 2½-inch drill to its full capacity in steel. The countershaft has a single-belt drive, each drill being provided with a foot-lever controlled clutch to engage the bevel gear on the line shaft.

The machine is provided with two knockouts for the feeds. The upper knockout *A* raises the worm out of the worm wheel. The lower one *B*, the lower bevel gear *C* out of mesh, leaving the spindle free to be fed down by the hand wheel *D* for facing. Either *A* or *B* knocks out the power feed. Tripping *A* stops the spindle and leaves it free to be fed down by the lever *E*, while dropping out trip *B* leaves the worm engaged.

Either knockout can be tripped by a stop, but not both with the same setting. If it is plain drilling *A* would be used, while for drilling and facing, *B* would be employed.

These machines are built with two or more spindles. The one shown in Fig. 1 is 86 inches high, occupies floor space 60x84 inches and weighs about 6000 pounds.

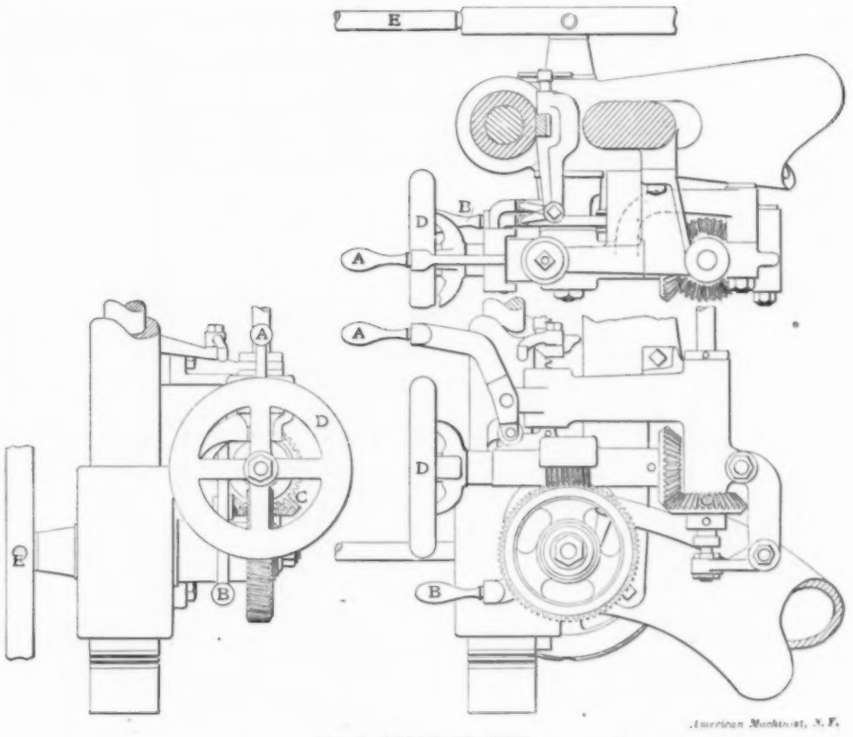


FIG. 2. DETAIL OF TRIPS

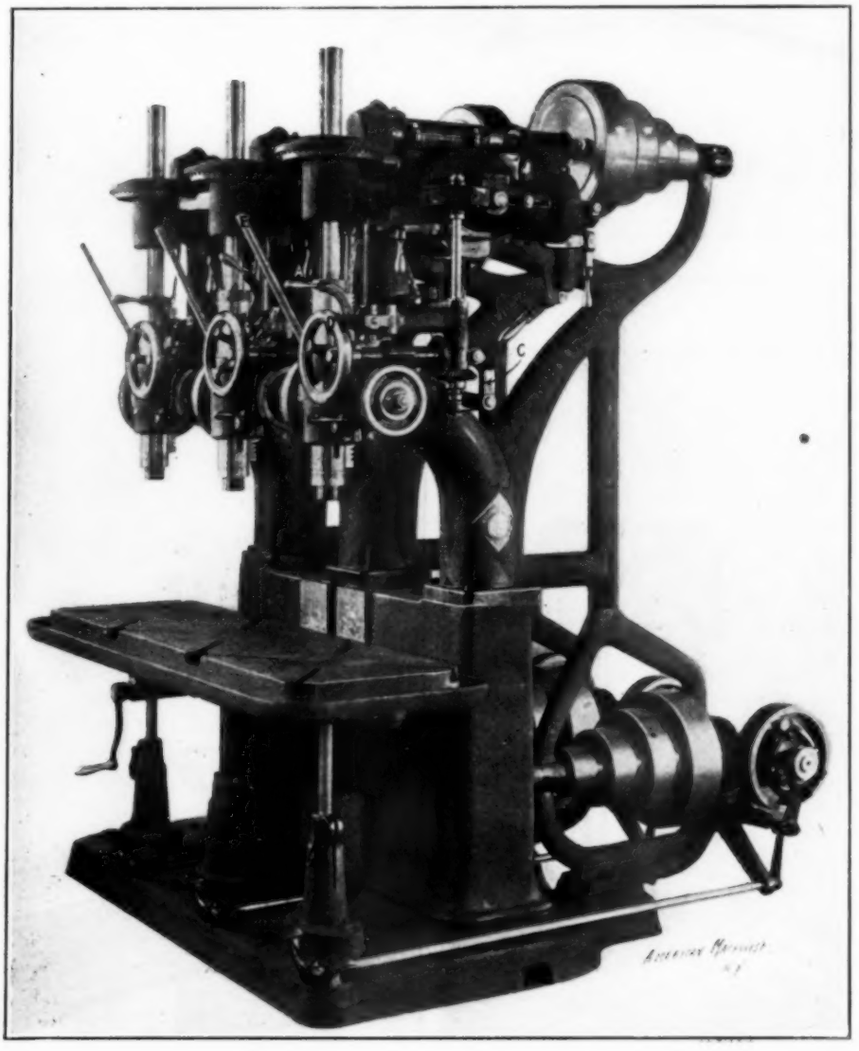
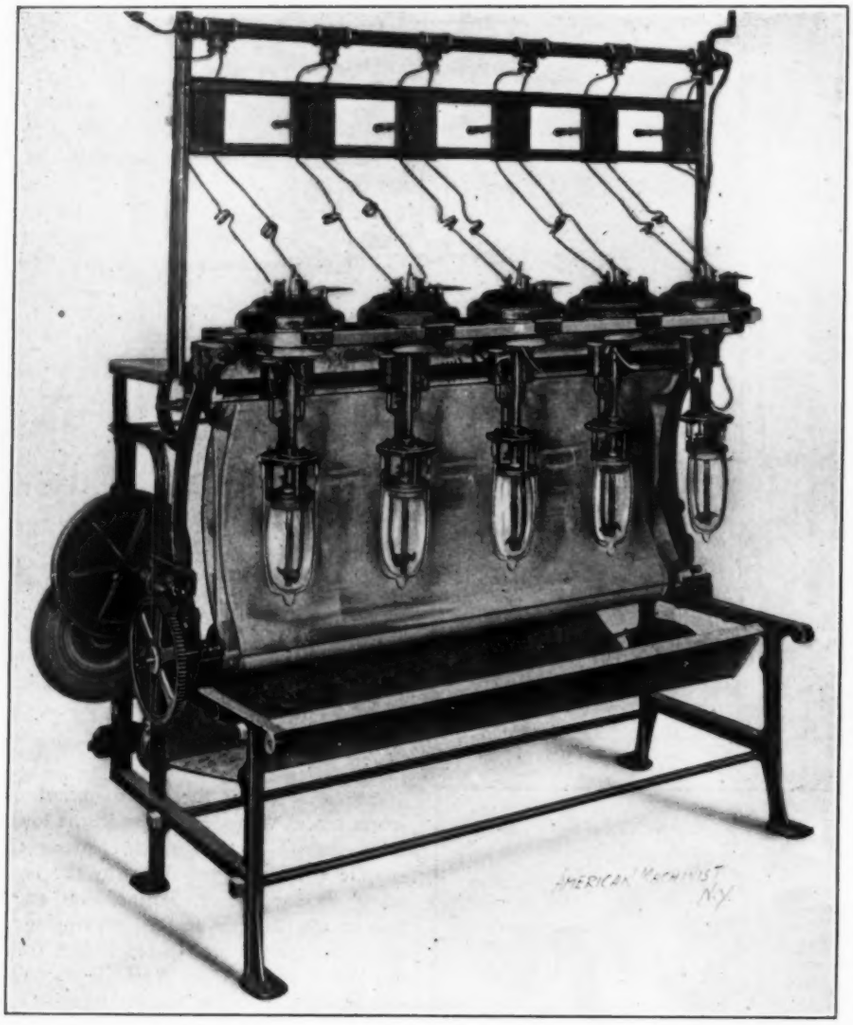


FIG. 1. A HEAVY-DUTY GANG DRILL

The Express Model Blueprinting Machine

This is offered as the most rapid blueprinting machine on the market when used in pairs, i.e., another machine placed in front of the lamps so that the same set furnishes light for both machines. This not only doubles the output of blueprints, but cuts the cost of current in half. The machine can be used in connection with any standard arc or mercury-vapor lamp as may be preferred.

As each side of this machine will print from 2 to 8 feet per minute, it has a maximum capacity of 16 feet of blueprints per minute at the cost of one set of lamps. Each side of the machine is entirely separate so that one can be run at its maxi-



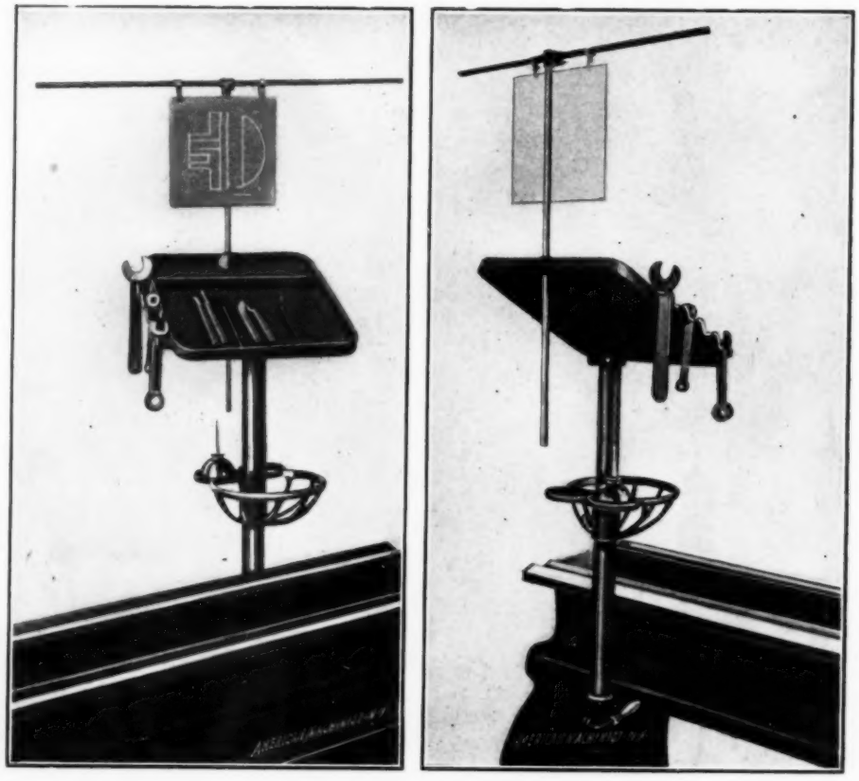
EXPRESS MODEL BLUEPRINTING MACHINE

mum speed for fast blueprinting, while the other is being run very slowly for sepia or negative work. This machine is built by Williams, Brown & Earle, 918 Chestnut street, Philadelphia, Penn.

Tool Rack for Lathe

The desire to keep tools, oil can, waste, etc., off the lathe has led to the design of many tool boards, but these all occupy room on the bed and need to be moved at times. The device shown with this consists of an upright clamped to the bed without the necessity of drilling or tapping of any kind.

This upright carries a waste pocket, a shelf for the oil can and a rack for tools. At the side of this rack are fingers for holding wrenches, files, or other tools, while at the back is a rod carrying a cross-bar from which blueprints or shop cards can be hung so as to be clearly visible and yet out of the way in every particular. Prints up to 26x30 inches can be held in this way. The tool rack is made by T. E. Wells & Son Company, Greenfield, Mass.



TOOL RACKS FOR LATHES

Adjustable Multiple Spindle Independently Varying Speed Drilling Machine

The question of running different sizes of drills at close centers, side by side on adjustable multiple-spindle drill presses each at its proper cutting speed seems to be taken care of by the machine illustrated.

The power is delivered by a friction pulley through the change-speed box and bevel gears to the main vertical shaft in the column. Five cone gears revolve on this main vertical shaft in the head and by means of three separate series of compound and idler gears deliver the power to each independent spindle gear.

These cone gears are thrown into commission by means of three sliding keys located in the shaft. One key engages the lowest gear, one key, the next two gears and the third key the two remaining gears. Thus three of these cone gears can be thrown into commission at one time and deliver their respective speeds to the spindle driving gear.

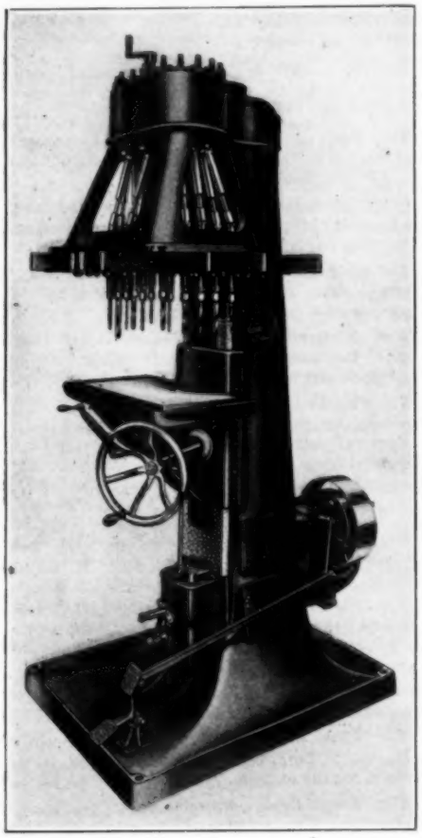
These cone gears are arranged so they will deliver 500, 750, 1000, 1500 and 2000 revolutions to the spindle gear.

Any one or two speeds in the above combination can be obtained on the spindle-driving gear. Thus if only one size drill is being used the other cone, compound and idler gears do not revolve providing the sliding keys in the shaft are disengaged. These changes, together with three changes in the speed box and three

in the feed box, will give any desired speed.

The spindle-driving gears are keyed to their respective driving shafts. By means of a bronze gear fork, through one end of which the spindle shaft runs and through the other end of which a screw operates, the spindle-driving gear is raised or lowered quickly into three different speeds or three neutral positions. Thus such spindles as are not in use can be placed in the neutral positions and remain idle.

The screw is operated from the top of the machine and indicators on each screw show the exact position of the spindle-driving gear within the head. Thus with



ADJUSTABLE MULTIPLE-SPINDLE DRILLING MACHINE

the initial speed in change-gear box fixed, any desired spindle speed can be obtained independently by the raising or lowering of the respective spindle gear within the head. A 1/16-, ⅛-, ¼-, ⅜- and ½-inch drill can be run side by side each at its proper cutting speed and maximum feed.

Ball races are placed between all of the main driving, compound and idler gears in the head, ring oilers in the speed box and ball thrust on top of the vertical shaft bearing in the column.

All gears are cut from the solid and all gears in the head, feed and speed box and vertical shaft within the head run in oil baths. An oil pump to provide continuous circulation of oil is located within the column on the change-gear box.

Attention is called to the unique construction of the universal joint. The cube and its four pieces are made from one solid piece, thus obviating the use of screws for connecting the cube and the driving sides. All wearing surfaces are hardened.

The work table is counterweighted, has both hand and power feed and is equipped with an automatic knockout.

The speed box has three changes of speed for cast iron, steel and brass and the sliding key change in the feed box gives 1½-, 3- and 4½-inches feed.

An oil pump and reservoir for lubricating the drills is also provided.

The machine is manufactured by the National Automatic Tool Company, of Dayton, Ohio, and is built in different sizes, the square head carrying up to twelve and the rectangular head up to twenty spindles.

Can Steel Be Hardened Properly in a Forge Fire?

By C. U. Scott

In previous articles to the American Machinist I have spoken of the forge fire as being one of the very poorest fires in which to heat steel for hardening. When we do our work under the most favorable conditions we can not see what we have done to the steel in the hardening without destroying the tool. Thus we continue to work blindfolded rather than remove the mask of the ancient forge.

In visiting manufacturing plants where but a few tools are made and asking what kind of an equipment they have, they will tell you that, as they do not have much hardening to do, their smith uses the forge for heating and gets pretty good results. But they have considerable trouble in hardening a certain brand of steel. It comes out of the water all right but after lying on the bench a while it cracks, or bursts, etc.

Again some will be so generous as to tell us: Oh! we use the forge for heating our tools for hardening, as there is nothing to it but to heat it up and cool it off again.

Let us visit the different places where they use heat in their work and see how willing we would be to have our work done under the same comparative difference that we find between a properly equipped and working hardening room and one with only the forge for heating.

First visit the laundry and find the linen drying in a drying room at a temperature of 400 degrees Fahrenheit; would we not be justified in surmising that something was going to happen to our linen and, therefore, send it somewhere else?

Next visit the manufacturers of rubber goods and find them heating rubber for vulcanizing in an oven with a temperature of 950 degrees Fahrenheit, which is about the proper heat for annealing glass. Would we place any orders with them?

Then turn to the tempering of tools and suppose a hardener was trying to draw the temper of a milling cutter to 430 degrees Fahrenheit in a bath of oil at a temperature of 570 degrees Fahrenheit. We can readily see that he would make a miserable failure.

Next turn to the man at the forge and place in his hands a die of ordinary size, say ¾x4x7 inches. He will build up a large fire, burn out the gases the best he can, leaving it well caked up, and place the tool in it and commence to take his heat. If we place a thermonipple just below the piece and another on top, we shall find as much as 800 degrees' difference in the readings of the two instruments. We can turn the piece as often as we like and the variation continues with but very little change. Should we place the thermonipples at the end and center of the piece we should see a greater difference.

After determining by actual test that our particular tools would do best if quenched at a temperature of 1470 degrees Fahrenheit, would we give them to the man with a forge for heating and expect him to get an even heat on a piece ¾x4x7 inches?

Some may think that this is possible but I do not, as there is a variety of heats being generated in the fire, and the operator has scarcely looked away from the fire from the time he began to take the heat. Hence his eyesight would begin to tire, causing him to waver and become confused in his judgment of heats.

I have seen pieces, ¾ inch around and 1¼ inches long, heated on a surface that was 900 degrees Fahrenheit, and one end would be 600 degrees before the top had reached a sufficient heat to produce a light straw color. Thus we can see that it is absolutely necessary to have the heat evenly generated and not produce more heat than is desired, on the piece to be hardened, if we would get a given heat on the entire surface of a tool.

This would mean that we should invest a few dollars in the equipment of a hardening room so we could give tools any heat that is desired. This can be accomplished only by heating the tools in a fire that does not generate more heat than is desired. If one corner of a die or tool becomes over heated even slightly in the hardening heat, the entire piece might as well be heated to the same heat, as the good part of the tool will have to be ground whenever the poor part of the tool gives away. Consequently if only part of the tool becomes hotter than is desired, for quenching, it should be taken from the fire, allowed to cool, and then be reheated for hardening.

The Cleveland Industrial Exposition

The Industrial Exposition just closed in Cleveland was originated by F. F. Prentiss, of the Cleveland Twist Drill Company and carried to a successful culmination under his chairmanship. It consisted of exhibits of Cleveland manufactures only and included all branches of industry, of which there is a large variety.

A very ingenious combination of staff-covered walls and a huge, water- and fire-proofed canvas roof was built and, with the armory gave a floor space of nearly 115,000 square feet.

The manufacturers responded freely, especially those in the machine-tool line, and the exhibits were very interesting in every way, while the attendance showed a marked enthusiasm on the part of the people at large. These exhibitions will probably be continued from year to year.

James Bennett Forsyth

James Bennett Forsyth, president and general manager of the Boston Belting Company, Boston, Mass., died in that city on June 11, 1909.

Forthcoming Meetings

National Gas and Gasolene Engine Trades Association, meeting, June 22, 23, 24, South Bend, Ind., headquarters, Oliver hotel. Albert Steitwatter, Cincinnati, Ohio.

Society for the Promotion of Engineering Education, seventh annual convention, June 24-25-26, Columbia University, New York, and Pratt Institute, Brooklyn, N. Y. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

The Society of Naval Architects and Marine Engineers, summer convention, June 24-26, Detroit, Mich., headquarters, Hotel Pontchartrain. W. J. Baxter, secretary, 29 West Thirty-ninth street, New York City.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J., Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

International Association for Testing Materials, fifth congress, Copenhagen, Denmark, September 7-11.

The American Institute of Electrical Engineers, twenty-sixth annual convention, June 28-July 1, headquarters, Hotel Frontenac, Thousand Islands, N. Y. Ralph W. Pope, secretary, 29 West Thirty-ninth street, New York City.

Business Items

The address of the American Tinol Company is 2100 Fairmount avenue, Philadelphia.

In order to simplify details in connection with correspondence, etc., the Quincy, Manchester, Sargent Company, Plainfield, N. J., has changed its name and will hereafter operate under the corporate name of Q. M. S. Co.

Preliminary returns for May show that the business of the Western Electric Company is running at the rate of between $46,000,000 and $48,000,000 per annum. This would make the gross returns for the first half of the company's fiscal year ended with May, show business of close to $23,000,000 or an average of nearly $4,000,000 a month.

Business Opportunities

The Erie (Penn.) Malleable Iron Company is enlarging plant.

Harrild & Son, Spokane, Wash., will erect a new furniture factory.

The American Skein Company, Racine, Wis., will add a new forge shop.

The Ailyne Brass Company, Cleveland, Ohio, will erect a large foundry.

The Gross Packing Company, Milwaukee, Wis., will build an addition.

Downer College, Milwaukee, Wis., will install additional boiler and engine.

The Oshkosh (Wis.) Excelsior Manufacturing Company is enlarging its plant.

Abner S. Deysher, Reading, Penn., will build an addition to his box factory.

The M. E. Roberts Company, Baltimore, Md., will erect a packing plant.

The Centralia (Wash.) Canning Company has secured a site for its plant.

James Pesch, Manitowoc, Wis., will erect an auto garage and repair shop.

The Rogersville (Mo.) Canning Company, a new concern, will erect a plant.

The Surpass Leather Company, Philadelphia, Penn., will build a new factory.

The Auto Body Company, Lansing, Mich., is preparing plans for new shops.

The Wisconsin Carriage Company, Janesville, Wis., is erecting an addition.

The Great Northern Railroad is building a new roundhouse at Marcus, Wash.

The Columbia Kindling Wood Company, Ashland, Me., will erect a new plant.

The Poison Iron Works, Toronto, Ont., will build a large new shipbuilding plant.

The San Diego (Cal.) Electric Railway Company has bought site for new car barns.

The Pacific Mills, Lawrence, Mass., will build a $2,000,000 cotton mill at Dover, N. H.

The Dorris Motor Car Company, St. Louis, Mo., will erect a $60,000 factory building.

The Hydraulic Pressed Steel Company, Cleveland, Ohio, will build an addition to plant.

The plant of the Massachusetts Box Company, at East Leverett, Mass., was burned.

The E. J. Balza Company, Green Bay, Wis., is to erect a pickle factory at Seymour, Wis.

The Stephens Point (Wis.) Foundry and Machine Company is in the market for a motor.

The New Jersey Worsted Spinning Company will erect a mill at Garfield, N. J., to cost $100,000.

The Andrae Stone and Marble Company, Milwaukee, Wis., will build an addition to plant.

The lumber mill of Smith & Rumery, Portland, Me., was destroyed by fire. Loss, $50,000.

Warren Webster & Co., Camden, N. J., manufacturing steam specialties, is building an addition.

The Southern Spring Bed Company, of Atlanta, Ga., will establish a branch plant at Memphis, Tenn.

The Milwaukee (Wis.) Street Railway Company has commenced construction of new car shops.

The plant of the Specialty Foundry Company, Zenienople, Penn., was burned. Loss, about $15,000.

The Sailor-Whitmore Machine Company, Menasha, Wis., has completed plans for a new foundry.

The Marathon Paper Mills, of Wausau, Wis., is increasing the capacity of its plant at Rothschild, Wis.

The Hasty Manufacturing Company, of Chicago, Ill., making safety valves, will locate in Elgin, Ill.

The plant of the Winston Handle Company, Winston-Salem, N. C., was destroyed by fire. Loss, $20,000.

The Buffalo (N. Y.) Specialty Company, manufacturing hardware specialties, will build a new factory.

The plant of the Salmon River Paper Mills at Milton, N. H., was destroyed by fire. Loss, about $100,000.

The Duncan Electric Manufacturing Company, Lafayette, Ind., will erect a new five-story factory building.

A contract has been awarded for an addition to the plant of the Electric Cable Company, Bridgeport, Conn.

The Fales & Jenks Machine Company, Pawtucket, R. I., is planning the erection of an addition to plant.

Brewster & Co., carriage makers, New York, will move to Long Island City, where a new plant will be erected.

The Chesapeake & Ohio Railroad is to spend about $450,000 in improvements at its shops in Huntington, W. Va.

The Hallack & Howard Lumber Company, Denver, Colo., is arranging for the construction of a $30,000 planing mill.

Cole Manufacturing Company, Charlotte, N. C. will erect plant for the manufacture of farming implements, etc.

The Katabdin Pulp and Paper Company, Lincoln, Me., is erecting an addition to be equipped as a machine shop.

The Portland (Ore.) Railway, Light and Power Company will expend $6,000,000 in extensions and improvements.

The Florida Land Company, Montbrook, Fla., contemplates establishing a plant for the manufacture of crates and baskets.

The Otis Elevator Company will build an addition to its plant in Buffalo, N. Y., to be equipped as a woodworking shop.

Kenfield & Lamoreaux, Washburn, Wis., are operating a sawmill, and will install new machinery in the addition recently built.

The Sharon (Penn.) Steel Hoop Company will enter the steel trade and is preparing plans for a four-mill plant to cost about $200,000.

The Tallman Brass and Metal Company, Hamilton, Ont., will erect a $10,000 foundry for manufacturing brass and babbitt metals.

The Foos Manufacturing Company, Springfield, O., is building an addition which is to be used for the manufacture of grinding plates.

The John Baker Manufacturing Company, Evansville, Wis., manufacturing windmills and gasolene engines, will erect three-story addition.

The Indiana Brass and Bronze Company, Marion, Ind., is making arrangements to enlarge its plant. A new machine shop will be erected.

A. H. Yocum & Co., Reading, Penn., will move into a new factory and install new equipment for the manufacture of automobile motors.

H. B. Barkis & Co., San Francisco, Cal., is building a plant at Lodi for the manufacture of grinding, conveying and elevating machinery.

The Tampa (Fla.) Foundry and Machine Works is to install additional machinery at a cost of $12,000 and will erect a tool room.

The New York Central & Hudson River Railroad is having estimates made for a roundhouse near Corning, N. Y., and one near Carthage, N. Y.

The Walla Walla (Wash.) Gas and Electric Company will enlarge plant. Plans for new sub-station and new car service are being considered.

The Davenport (Iowa) Locomotive Works is building two additions, one to be an erecting and machine shop, the other a hammer and forge shop.

It is reported that W. P. Snyder & Co. of

ittsburg is planning the construction of another large furnace at Sharpsville, casting about $1,000,000.

Proposals for a jib crane for the Norfolk Navy Yard will be received until 11 o'clock a.m., July 10, at the Bureau of Yards and Docks, Navy Department, Washington, D. C.

The Welch Motor Car Company, of Pontac, Mich., will establish a factory in Detroit for the manufacture of a smaller and less expensive car than is now being made at Pontiac.

Proposals for turbo-alternators for New York, Philadelphia and Boston navy yards will be received until 11 a.m., July 10, at the Bureau of Yards and Docks, Navy Department, Washington, D. C.

The Augustine Automatic Rotary Engine Company, Ellicott Square Building, Buffalo, N. Y., is about to engage in the manufacture of rotary engines and will need horizontal boring mills of 4-feet, 6-feet and 30-inch swing, radial drills, milling machines, key-seating machine, slotter, grinding machine, hydraulic press, hardening furnace, etc.

The American Sheet and Tin Plate Company of Pittsburg has appropriated $200,000 for the Laughlin and Aetna-Standard plants. A 20-ton crane is to be installed at the former, a new boiler house will be built at the latter and new boilers, automatic stokers and ash-handling devices installed. A 5-ton crane will be installed in the roofing department.

The De Schaum-Hornell Motor Company, Hornell, N. Y. is preparing plans for a plant at North Hornell. The equipment needed will be bulldozers, stamping and rolling machinery, lathes, planers, drills, grinding machinery, etc. W. A. De Schaum is manager. His present address is care Lincoln Paul & Newsome Company, 18 Court street, Buffalo, N. Y.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: June 29—Surface condenser (schedule 1338), locomotive (schedule 1136), platform scales (schedule 1357), chisels, clamps, files, hacksaws, hammers, wrenches, screws (schedule 1360); files (schedule 1359), brass bolts, sheet zinc (schedule 1362); July 6—oil fuel system (schedule 1354), outfit for the manufacture of steel castings (schedule 1370), erecting four water-tube boilers (schedule 1372); July 13—annunciators, controllers, carbons, heaters, voltmeters, etc. (schedule 1364); remodeling 110-ton electric traveling crane (schedule 1273); July 20—electric freight elevators (schedule 1353).

New Incorporations

The Saxony Spinning Company, Lincoln, N. C., has been organized by Edgar Love to build a mill for the production of fine yarns.

The K. E. Auto Electric Manufacturing Company, Gadsden, Ala., has been incorporated to manufacture automobiles. Capital, $10,000. Kyle Elliott, president.

The Arkansas Foundry Company, Little Rock, Ark., has been incorporated. Capital, $25,000. Incorporators, T. H. T. Rogers, F. I. Brown, Eugene Vogler, etc.

The Black Crow Manufacturing Company, Babylon, Ill., has been incorporated to manufacture air ships. Capital, $35,000. Incorporators, I. Hubbell, F. W. Moore, M. Hubbell, Fulton.

The Garwood Bronze and Iron Works, Garwood, N. J., has been incorporated to conduct a general foundry business. Capital, $100,000. Incorporators, W. S. Tuttle, J. C. Land, E. E. Field, Jr.

The Vincennes Machine Company, Vincennes, Ind., has been incorporated to manufacture washing machines. Capital, $10,000. Incorporators, E. A. Ritterskamp, Benj. Niehaus, C. G. Ritterskamp.

The Bernhardt Manufacturing Company, Edwardsville, Ill., has been incorporated with $30,000 capital by Peter Bernhardt, Chas. Gerling and John Stolze. The company will manufacture and deal in machinery, implements, etc.

The Geneva (Ala.) Power and Manufacturing Company is being incorporated with $500,000 capital to build a cotton mill and hydroelectric plant. Incorporators, D. O. Vaughan, D. G. McInnis, D. H. Morris, A. M. McKinnon, of Geneva.

The Jewel Engineering Company, Paterson, N. J., has incorporated as mechanical and electrical engineers, toolmakers, etc. Capital, $50,000. Incorporators, E. Whittaker, Haledon, N. J.; E. Livingstone, F. W. Johnson, G. A. Fischer, Paterson.

The Lees-Bradner Company, Cleveland, Ohio, has been formed to put on the market a new automatic-gear generator, invented by E. J. Lees. E. J. Lees and H. T. Bradner, composing the company, were formerly connected with the Grant-Lees Machine Company.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

To Trade—One 24"x20' or one 26"x16' engine lathe for 8" pipe threading machine. Shartle Bros. Machine Co., Middletown, O.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—To manufacture, in modern fireproof machine shop, small specialties in brass or iron. Box 273, AMERICAN MACHINIST.

Wanted—Designs and prices of machines for tapping iron pipe fittings two to six inch. Box 126, AMERICAN MACHINIST.

I have specialty for automobile trade; can be sold readily at good profit; desire correspondence with manufacturer possessing good facilities. Address Box 339, AMER. MACH.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply BOX 189, AMERICAN MACHINIST.

Special machines designed and built, estimates furnished; inventions developed to a practical and commercial basis. Benj. Brownstein, mechanical engineer and expert designer, Gundling Bldg., Trenton, N. J.

Have a first-class machine shop and am desirous of extending my line. Have means and experience to handle, sell, represent and act as agent for a high class steam engine or other machinery concerns seeking representation in New York. Parties interested reply, Box 336, AMERICAN MACHINIST.

Auction Sale—The machinery and tools of the former A. A. Griffing Iron Company, Jersey City, N. J., on July 7 and 8, at 11 o'clock a.m., consisting of a variety of machine tools, lathes, planer, drills, Ingersoll 10'x48" miller with tool sharpener, eight arbors, Pedrick & Ayer pneumatic and air hoists, foundry cranes, 125-horsepower Ball tandem engines, Norwalk air compressor, pumps, chain hoists, vises, belting, office furniture, Mosler safe, etc. Catalogs after June 21 on application by mail or otherwise, to F. W. Smith, 104 West 42nd St., New York.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Factory accountant and systematizer desires to install and supervise a system of factory accounting which will produce advantageous results. Box 296, AMER. MACH.

DELAWARE

Mechanical draftsman experienced mostly on machine tools, wishes to change. Box 338, AMERICAN MACHINIST.

MASSACHUSETTS

Graduate M. I. T. desires change in responsible position; experience, 20 years' as designer, mechanical engineer and superintendent on variety of work including interchangeable manufacturing; best of references. Box 351, AMERICAN MACHINIST.

Practical mechanic; broad experience as general foreman and superintendent; good executive ability; has thorough knowledge of modern shop practice; the use of high-speed steel and interchangeable manufacture; American; 35. Box 282, AMERICAN MACHINIST.

MICHIGAN

Mechanical and civil engineer, technical graduate, energetic, aggressive and systematic, 16 years' experience as designer, chief draftsman and engineer, conversant with both mechanical and structural work, desires responsible position with first-class firm in engineering or executive capacity. Box 347, AMERICAN MACHINIST.

MISSOURI

Graduate mechanical engineer, with eight years' experience as machinist, foreman and tool designer, desires engineering or executive position. Age 33. Box 326, AMER. MACH.

NEW JERSEY

Mechanical engineer, chief draftsman and designer; experienced in steam engineering and pumping machinery, is open for responsible position. Box 343, AMER. MACHINIST.

Have you a position of responsibility that you are hesitating to fill? Does it require a resourceful man of character, experience and ability? One who takes a personal interest in his work aside from the salary? If so, look up my record and give me the opening. Box 332, AMERICAN MACHINIST.

Draftsman and first-class all-round mechanic, 28, with eleven years' shop experience, four years' as superintendent designer of special machinery, wishes position where he can make use of his practical knowledge. At present employed. Address: "J. G.," 936 Bloomfield St., Hoboken, N. J.

Executive, with exceptional experience in the different branches of manufacturing, now with large firm, wishes position of responsibility with small growing concern, country preferred. Box 331, AMERICAN MACHINIST.

NEW YORK

An A-1 designer wishes change. Originator and developer of machines and methods that meet requirements. Box 329, AMER. MACH.

Experienced mechanical designer and superintendent, eight years' experience automatic and general machinery, wishes responsible position. Box 350, AMERICAN MACHINIST.

Up-to-date mechanical engineer, first-class mechanic, designer, erecting and shop engineer, 12 years' experience, age 33, wants position. Box 345, AMERICAN MACHINIST.

Young man, good mechanical and executive experience on instrument and tool work, desires responsible position. Good on design, practice and estimates. Box 335, AMERICAN MACH.

Designing engineer, 17 years' experience, educated; practical mechanic, expert on automatic machines, both light and heavy, and tools. Capable, original, successful. Any locality. $2500 per year. Box 285, AMER. MACH.

Do you want a man to take charge who knows the manufacturing business from the bottom up? Who is a successful organizer, executive? Not the "brain broker's" variety, but whose present job is a recommendation in itself? Box 330, AMERICAN MACHINIST.

PENNSYLVANIA

Tool and diemaker with broad training on all kinds of tools, long experience in sheet-metal work; also experimental work; could handle men to advantage. Box 337, AM. MA.

WASHINGTON

Pattern-maker foreman at liberty, expert draftsman and designer, experienced in "logging engines," gasolene engines, marine and other classes. Five years on Coast. Box 328, AM. M.

Help Wanted

Classification indicates present address o advertiser, nothing else.

CANADA

Wanted—First-class toolmakers and machinists, accustomed to automobile, jig and fixture work. Apply Reo Motor Car Co. of Canada, Ltd., St. Catharines, Ont.

CONNECTICUT

Wanted—A new company starting its factory in Connecticut desires applications for employment from draftsmen, foremen, toolmakers and general machine operators. The work is along the line of adding machines, fire arms and typewriters, requiring interchangeable parts and high grade workmanship. Men having experience in this line of work, who can prove themselves capable men, are desired only. To such men permanent positions are offered, with ample opportunity for advancement. In reply, give age and references, which will be treated confidentially if so desired. Box 314, AMERICAN MACHINIST.

ILLINOIS

Wanted—Speed boss for machine shop employing about forty workmen. Box 341, AMERICAN MACHINIST.

Expert blacksmith and annealer wanted in automobile factory; one thoroughly acquainted with case hardening and treating all kinds of steels; good wages, permanent position. Box 327, AMERICAN MACHINIST.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

Wanted—Man experienced in case-hardening and heat-treating small carbon and nickel-steel parts; state age, experience and give reference. Box 322, AMERICAN MACHINIST.

MARYLAND

Wanted—Three or four first-class draftsmen on heavy general machinery, structural and general arrangement work. Address Ellicott Machine Company, Baltimore, Md.

MASSACHUSETTS

Wanted—Mechanical designer experienced on both light and heavy work, for position in Massachusetts. State age, experience and salary expected. Address "ZYX," care AM. MA.

Wanted—At Leominster, Mass., mechanical draftsman with experience in hydraulic and general line of machinery; state age, nationality, technical and practical training, previous employment and salary expected. Address Box 152, Leominster, Mass.

First-class mechanical draftsman and designer who has had extended experience on steam-engine design, also one thoroughly familiar with the mechanical design of electrical apparatus, wanted for permanent positions. Only competent men need apply by giving full particulars about age, education, experience and salary expected. Address "Engineer-in-Charge," Drawing Office, General Electric Co., West Lynn, Mass.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

NEW JERSEY

Taylor Iron and Steel Company, High Bridge, N. J., wish to employ sober boiler maker thoroughly familiar with layout and construction of tank work. Address Purchasing Agent, stating experience and salary."

NEW YORK

First class blacksmiths and tool dresser wanted. Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Toolmakers Wanted—Experienced on fine tool and fixture work; state age, experience in detail and rate per hour expected. Box 344, AMERICAN MACHINIST.

Wanted—Machinist to operate Gould & Eberhardt, Pratt & Whitney gear cutters and Grant hobbing machines. Must be thoroughly experienced in gear cutting. State previous experience and pay expected. Otis Elevator Company, Yonkers, N. Y.

OHIO

One competent foundry foreman to handle piece work in gas-engine foundry. Box 340, AMERICAN MACHINIST.

Wanted—Machinist foreman, milling and screw-machine departments; age 30 to 40; state experience. The Oster Mfg. Company, Cleveland, Ohio.

Wanted—An experienced man to introduce and sell bolt and nut machinery; state references, age, salary expected and extent of experience. "H," Box 349, AMER. MACHINIST.

Wanted—Planer, lathe, vertical and spindle milling machine hands, bench and floor hands, brass foundry foreman; increasing capacity of plant. 201 Nicholas Bldg., Toledo, Ohio.

Wanted—Designer and draftsman; one who understands designing and general line of drilling machines; only experienced man who can give best reference and has shown results need apply. "Machine Tool," AMERICAN MACHINIST.

Wanted—Machinists; only good men need apply; for crank lathe, planer, boring mills and bars, radial drill, Jones & Lamson screwing machines and lathe; increasing force, steady work, good wages. Box 348, AM. M.

PENNSYLVANIA.

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Foreman familiar with cam shaft grinder and Lo-swing lathes. Reply, stating expreience and wages desired. Box 333, AM.Ma.

Wanted—Turret and screw machine foreman, familiar with Jones & Lamson and Potter & Johnston lathes. Reply, stating experience and wages desired. Box 334, AMERICAN MACHINIST.

Wanted—Mechanical draftsmen, with experience on electrical apparatus, generators, motors and transformers. State experience and salary expected. Only first-class men need apply. Address "Chief Draftsman," Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

Wanted—A good live agent in every soph or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie. Pa.

Wanted—First-class diemakers, toolmakers, experimental men and model makers with wide experience on adding machine, typewriter, cash register and gun work. Our factory is of the most modern type. Our tool and machinery equipment, likewise. We have a large variety of new high grade tools to build that demand the services of first-class workmen only. In reply state age, experience, salary expected and references. Box 346, AMERICAN MACHINIST.

Wanted—Foreman for our automatic screw machine department. Applicants must be thoroughly experienced on Brown & Sharpe, Potter & Johnston and Cleveland automatics. We do a very large variety of work to limits of within 0.0005 inch. The man we secure for the position must understand forwarding work from his department rapidly as well as accurately. In reply, please state experience, salary expected, references and age. Box 342, AMERICAN MACHINIST.

WISCONSIN

Wanted—To correspond with first-class draftsman who has had thorough experience. Wood working machinery line preferred. Box 315, AMERICAN MACHINIST.

For Sale

For Sale—One 40-horsepower Buckeye late model engine; one Imperial 22-kilowatt, 125-volt, direct-current generator. Both A-1 condition. Address the Woods Engineering Co., Alliance, O.

For Sale—Two 3-ton Yale & Towne chain twin-hoists. Used 5 months; in good condition. Hurley Track Laying Machine Co., Chicago, Ill.

For Sale or to Rent—A fully equipped, up-to-date foundry and machine shop, erected 1907, situated on Erie Railroad. Address Lock Box 30, Savona, N. Y.

For Sale—The only foundry in a large lead field. Well established, best equipment, good iron-clad buildings, own water works. Have done a good business all along the hard times. Will sell for one-half of actual cost, which is $16,000.00. Box 288, AMERICAN MACHINIST.

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Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
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Arbors

Cleveland Twist-Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
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Union Mfg. Co., New Britain, Conn.
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Boker & Co., Hermann, New York.

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Lyon Metallic Mfg. Co., Aurora, Ill.

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Beaman & Smith Co., Prov., R. I.
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Krieger Tool & Mfg. Co., Chicago, Ill.
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Boston Gear Works, Norfolk Downs, Mass.
Hess-Bright Mfg. Co., Philadelphia, Pa.
Hyatt Roller Bearing Co., Harrison, N. J.
Pickering Governor Co., The, Portland, Conn.

Belt Clamps

Hoggson & Pettis Mfg. Co., New Haven, Conn.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
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Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

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Benches, Work

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Niles-Bement-Pond Co., New York.
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Long & Allstatter Co., Hamilton, Ohio.
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Obermayer & Co., S., Cincinnati, O.

Cement, Iron

Smooth-On Mfg. Co., Jersey City, N. J.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Cincinnati Planer Co., Cincinnati, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chucking Machines

American Tool Wks. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Garvin Mach. Co., New York
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Ashburnham, Mass.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morrow Mfg. Co., Elmira, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Union Mfg. Co., New Britain, Conn.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.

Chucks, Lathe —*Continued.*

Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Magnetic

Walker & Co., O. S., Worcester, Mass.

Chucks, Planer

Cincinnati Planer Co., Cincinnati, O.
Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.

Chuck, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Starrett Co., L. S., Athol, Mass.

Clocks, Watchmen's

Hardinge Bros., Chicago, Ill.

Clutches, Friction

Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
Moore & White Co., Philadelphia, Pa
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Oesterlein Mach. Co., Cincinnati, Ohio.
Patterson, Gottfried & Hunter, New York.
Reeves Pulley Co., Columbus, Ind.
Wheeling Mold Fdry. Co., Wheeling, W Va.
Williams Foundry & Machine Co., Akron, Ohio.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Compound, Core

Obermayer Co., S., Cincinnati, O.
Universal Fluxine Co., Urbana, O.

Compound, Pipe Joint

Acheson Graphite Co., International, Niagara Falls, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Smooth-On Mfg. Co., Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Bury Compressor Co., Erie, Pa.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co. Chicago, Ill.
Ingersoll-Rand Co., New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York.

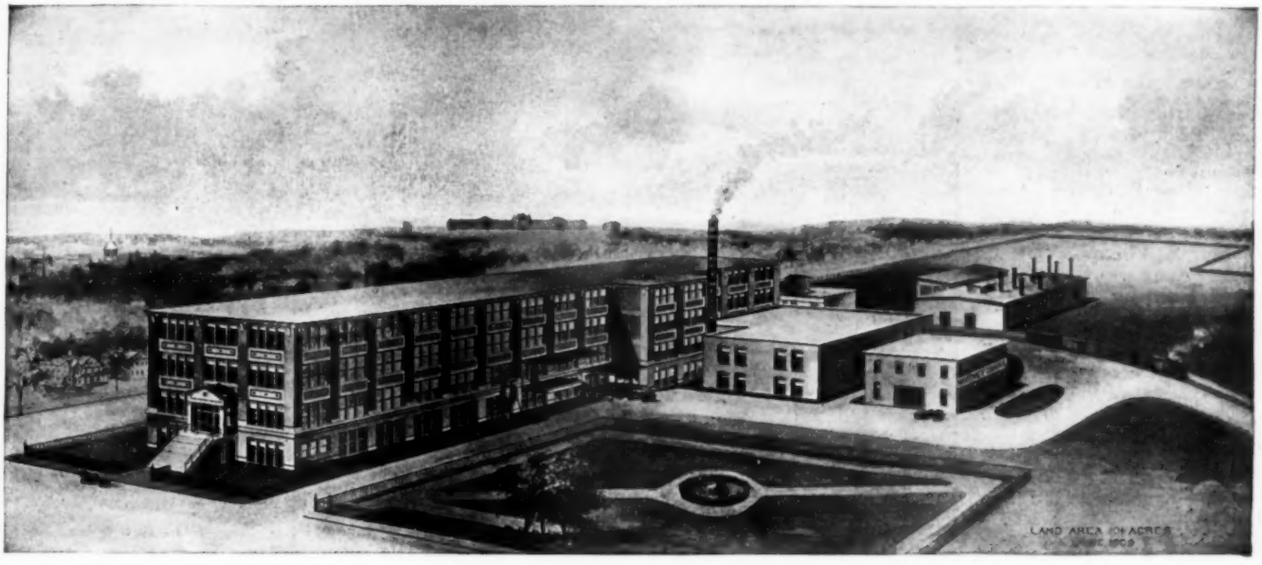
Conduit Interior

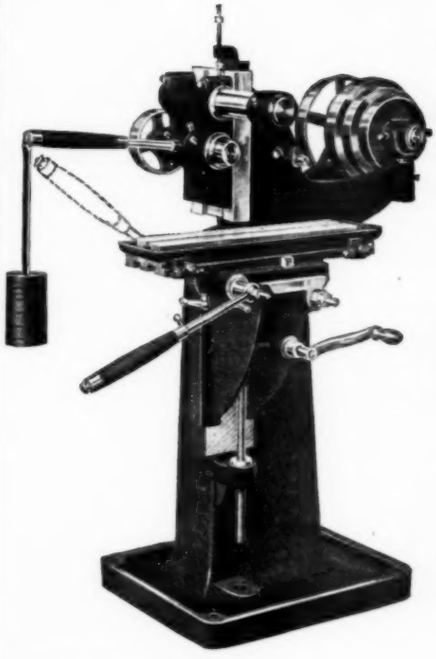
Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

"Whitney" Chains, Hand Millers, Machine Keys, etc., are made in a modern fire-proof factory.

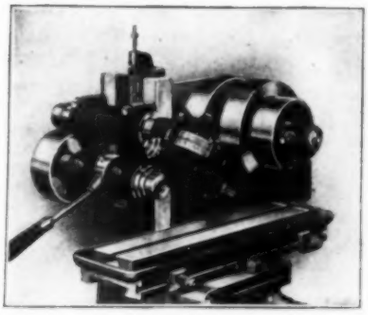


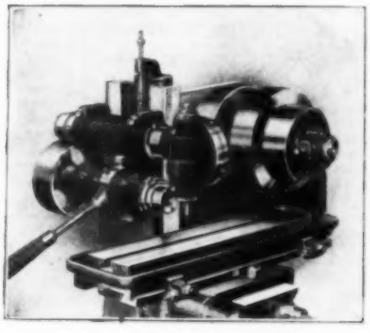


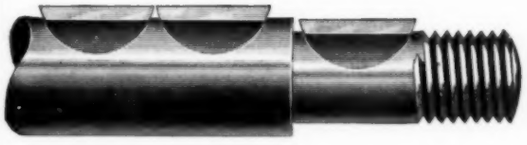
This New Vertical Universal High Speed Milling Attachment makes the

"Whitney" Hand Miller

one of the most complete and desirable tools on the market for a wide range of work.







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it will pay you to investigate.

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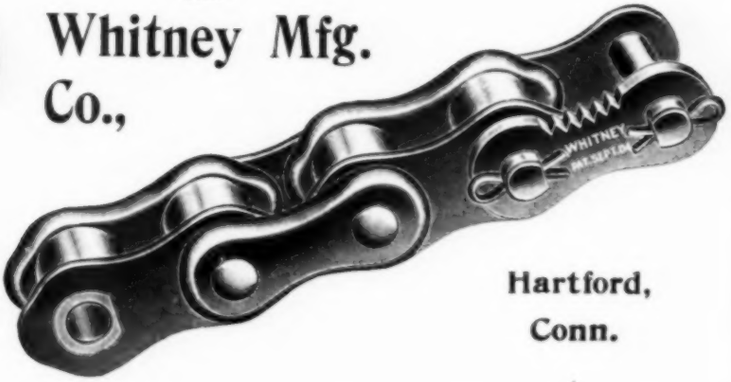


Hartford, Conn.

Connecting Rods and Straps
Electric Welding Products Co. Cleveland, Ohio.
Standard Connecting Rod Co., Beaver Falls, Pa.

Contract Work
Blanchard Machine Co., Cambridge, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Merritt, Jos., Hartford, Conn.
Morrow Mfg. Co., Elmira, N. Y.
Owen Machine Tool Co., Springfield, O.
Rowbottom Machine Co., Waterbury, Conn.
Schaeffer Mach. Wks., Phila., Pa.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric
Crocker-Wheeler Co., Ampere, N. J.
Cushman Electric Co., Concord, N. H.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveying Machinery
Link-Belt Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitman & Barnes Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Revolution
Grant Mfg. & Machine Co., Bridgeport, Conn.
Root Co., C. J., Bristol, Conn.
Schuchardt & Schutte, New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Ashburnham, Mass.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Dill Drive People, Phila., Pa.
Evans Friction Cone Co., Newton Centre, Mass.
Garvin Machine Co., New York.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Moore & White Co., Phila., Pa.
Norton Grinding Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Smith Countershaft Co., Boston, Mass

Countershafts, Friction
Dill Drive People, Phila., Pa.
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Counting and Printing Wheels
Franklin Mfg. Co., Syracuse, N. Y.

Couplers, Hose
Greene, Tweed & Co., New York.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Couplings
Almond Mfg. Co., T. R., Asbburnham, Mass.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y
Moore & White Co., Phila., Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, New York.

Couplings—*Continued.*
Sellers & Co., Inc., Wm., Philadelphia, Pa
Standard Gauge Steel Co., Beaver Falls, Pa.
Williams Fdry. & Mach. Co., Akron, Ohio.

Cranes
Browning & Co., Victor R., Cleveland, Ohio.
Cleveland Crane & Engineering Co., Wickliffe, Ohio.
Link Belt Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Morgan Construction Co., Worcester, Mass.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Shaw Electric Crane Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
United Engineering & Foundry Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Niles-Bement-Pond Co., New York.

Cupolas and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Boker & Co., Hermann, New York
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker, Milwaukee, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Owen Mach. Tool Co., Springfield, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass
Whitney Mfg. Co., Hartford, Conn.

Cutting-Off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Huriburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slack Mfg. Co., Springfield, Vt.
Vandyck Churchill Co., New York.

Cutting-Off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Davis-Bournonville Co., New York.
Krieger Tool & Mfg. Co., Chicago, Ill.

Cutting-off Tools—*Continued.*
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Ready Tool Co., The, New Haven, Conn.

Cyclometers
Veeder Mfg. Co., Hartford, Conn.

Diamond Tools
Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Risdon Tool Works, Inc., Waterbury, Conn.
Stearns Stamping Co., W. H., Worcester, Mass.

Dies, Sub-Press
Risdon Tool Works, Inc., Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Drawing Boards and Tables
Keuffel & Esser, Hoboken, N. J.
Morse Chk Co., New York.
Whitney ing Instruments
Keuffel & Esser Co., Hoboken, N. J.

Drawing Materials
Kolesch & Co., New York

Drafting Machines
Emmert Mfg. Co., Waynesboro, Pa.
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler
American Tool Works Co., Cin., O.
Cincinnati Bickford Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, O.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Sellers & Co., Inc., Wm., Phila., Pa.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Cincinnati Bickford Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio
Fosdick Mach. Tool Co., Cin., O.
Garvin Mach Co., New York.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.

Drilling Machines, Multiple Spindle —*Continued.*
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Taylor & Fenn Co., Hartford, Conn.

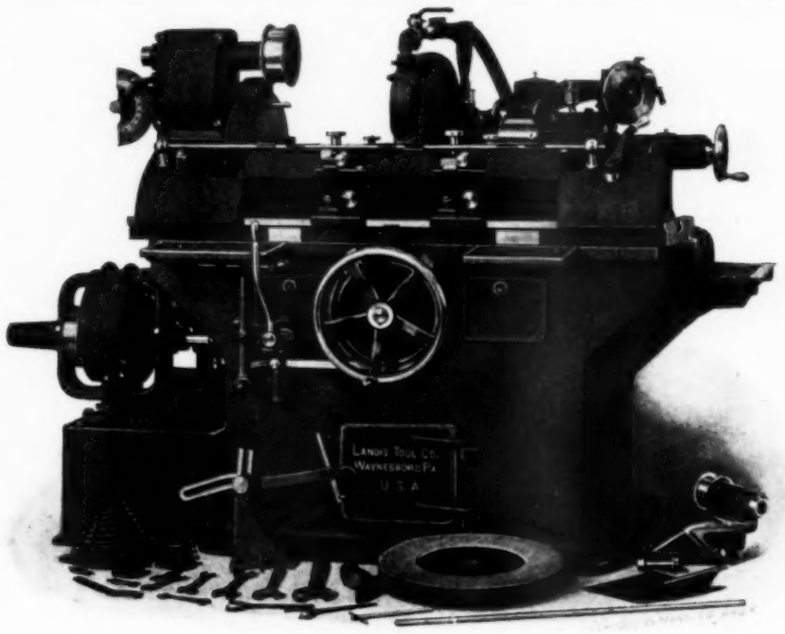
Drilling Machines, Portable
Cincinnati Electric Tool Co., Cincinnati, Ohio.
Coates Clipper Mfg. Co., Worcester, Mass.
Fortuna Machine Co., New York.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach Co., Cin., O.
Ingersoll-Rand Co., New York.
Newton Machine Tool Wks., Inc, Phila., Pa.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
Ameri an Tool Works Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Cincinnati Bickford Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O
Mueller Mach. Tool Co., Cin., O.
Newton Mach. Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Rail
Foote-Burt Co., Cleveland, O.
Newton Machine Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Phila., Pa.
Standard Tool Co., Cleveland, O.

Drilling Machines, Turret
Fay Machine Tool Co , Phila., Pa.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Celfor Tool Co., Buchanan, Mich.
Cincinnati Bickford Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O
Foote-Burt Co., Cleveland, O.
Garvin Mach. Co., New York.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Mach. Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.



Automobile Manufacturers

This Landis 12 x 32 Plain Grinding Machine is the best for grinding Automobile Gas Engine Pistons. The picture shows fifty-nine Pistons, each 4½″ diameter, 5½″ long. They are ground to size within .0005 inch variation limit and .025 inch removed—average time to grind each being only 4 minutes.

On Landis Plain Grinding Machines the grinding wheel traverses, not the work.

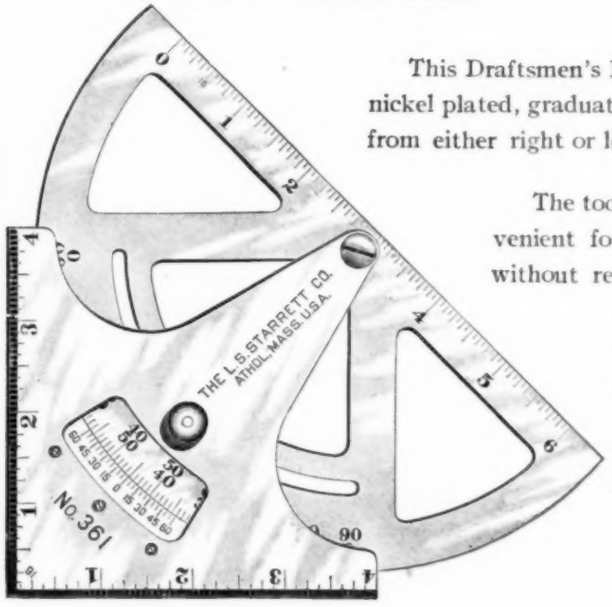
Send for Catalog.

Landis Tool Company,

Waynesboro, Pa., U. S. A.

Starrett Tools

For Draftsmen!



This Draftsmen's Protractor is made of sheet steel, nickel plated, graduated in degrees and figured to read from either right or left, with vernier to read in five minutes.

The tool will lie flat on the paper; knurled locking nut is convenient for picking up the instrument; angles can be reversed without resetting; by loosening the binding nut, friction is taken off, making it easy to adjust to degrees, when the tool may be again firmly locked.

Let us send you Catalog 18C describing all the Starrett tools.

THE L. S. STARRETT CO. :: Athol, Mass., U. S. A.

New York—132 Liberty St. Chicago—18-20 West Randolph St. London—36 and 37 Upper Thames, E. C.

Drilling Machines, Upright —*Continued.*
Sibley Machine Tool Co., South Bend, Ind.
Sloan & Chace Mfg. Co., Newark, N. J.
St. Louis Machine Tool Co., St. Louis, Mo.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Independent Pneumatic Tool Co., Chicago, Ill.
Van Dorn Elec. & Mfg. Co., Cleveland, O.

Drills, Flat
American Specialty Co., Chicago, Ill.
Lincoln Williams Twist Drill Co., Taunton, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Coates Clipper Mfg. Co., Worcester, Mass.
Fortuna Machine Co., New York.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Boker & Co., Hermann, New York.
Cleveland Twist Drill Co., Cleveland, O.
Greene, Tweed & Co., New York.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.

Drills, Rock
Fort Wayne Electric Works, Fort Wayne, Ind.
Ingersoll-Rand Co., New York.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Crocker-Wheeler Co., Ampere, N. J.
Electro Dynamic Co., Bayonne, N. J.
Garwood Electric Co., Garwood, N. J.
General Electric Co., New York.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Wagner Electric Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Crocker-Wheeler Co., Ampere, N. J.
Cushman Electric Co., Concord, N. H.
Electro Dynamic Co., Bayonne, N. J.
Fort Wayne Eletoric Works, Fort Wayne, Ind.
General Electric Co., New York.
Pearce Co., Fred'k, New York.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Triumph Electric Co., Cincinnati, O.
Van Dorn Elec. & Mfg. Co., Cleveland, O.
Wagner Electric Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.

Electrical Supplies—*Cont.*
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Works Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Cushman Electric Co., Concord, N. H.
Electro Dynamic Co., Bayonne, N. J.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Van Dorn Elec. & Mfg. Co., Cleveland, O.
Western Electric Co., Chicago, Ill.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Eastern Machinery Co., New Haven, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co,. Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Greene, Tweed & Co., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enamel Machinery
Felton, Sibley & Co., Phila., Pa.

Enclosures, Tool-Room
Hart & Cooley Co., New Britain, Conn.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.

Engineers, Mechanical or Electrical
Crocker-Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.
Link Belt Co., Philadelphia, Pa.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.

Engines, Motor
Franklin Mfg. Co., Syracuse, N. Y.

Engines, Steam
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Watson Stillman Co., New York.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Fort Wayne, Ind.
General Electric Co., New York.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Wagner Electric Mfg. Co., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.

Files and Rasps
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.

Files and Rasps—*Continued.*
Heller Bros. Co., Newark, N. J.
National File and Tool Co., Philadelphia, Pa.
Nicholson File Co., Prov., R. I.
Patterson, Gottfried & Hunter, New York.
Reichhelm & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

File Sharpening Machines
American File Sharpener Co., New York.

Filing Machines
Simplex Mfg. Co., New York.

Filler, Iron
Felton, Sibley & Co., Philadelphia, Pa.

Fittings, Hydraulic
Watson Stillman Co., New York.

Flanges
Jefferson Union Co., Lexington, Mass.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

Forges
Bradley & Son, C. C., Syracuse, N. Y.
National Machinery Co., Tiffin, O.
Patterson, Gottfried & Hunter, New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Chicopee, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Steel
Philadelphia Steel & Forge Co., New York.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Frictions, Paper and Iron
Rockwood Mfg. Co., Indianapolis, Ind.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Hoskins Mfg. Co., Detroit, Mich.
Rockwell Furnace Co., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Electric
General Electric Co., New York.
Hoskins Mfg. Co., Detroit, Mich.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Rockwell Furnace Co., New York.
U. S. Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Obermayer Co., S., Cincinnati, O.

Furnaces, Oil
Rockwell Furnace Co., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Welding
Davis-Bournonville Co., New York.
Industrial Oxygen Co., New York.
Sanford Mfg. Co., F. C., Bridgeport, Conn.
Toledo Electric Welding Co., Toledo, Ohio.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Manufacturing Equipment & Engineering Co., Goston, Mass.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Gages, Steam
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co. Boston, Mass.

Gaskets
Greene, Tweed & Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Bilgram Machine Works, The, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Shaper Co., Cincinnati, Ohio.
Fellows Gear Shaper Co., Springfield, Vt.
Flather Mfg. Co., E. J., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morse, Williams & Co., Philadelphia, Pa.
Motch & Merryweather Co., Cleveland, Ohio.
Newark Gear Cutting Machine Co., Newark, N. J.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schuchardt & Schutte, New York.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Van Dorn & Dutton Co., Cleveland, Ohio.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waltham Machine Works, Waltham, Mass.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.

Gears, Cut
Adams Co., The. Dubuque, Iowa.
Bilgram Machine Works, The, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Cincinnati Gear Co., Cincinnati, Ohio.
Clough, R. M., Tolland, Conn.
Earle Gear & Machine Co., Philadelphia, Pa.
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Gears, Cut—*Continued.*

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Lea Equipment Co., New York.
Morgan Construction Co., Worcester, Mass.
Morse, Williams & Co., Phila., Pa.
Newark Gear Cutting Machine Co., Newark, N. J.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Owen Mach. Tool Co., Springfield, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Quride Co., Syracuse, N. Y.
Sawyer Gear Works, Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Woburn Gear Works, Woburn, Mass.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., The, Cleveland, Ohio.
hiladelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.

Gears, Quride

Quride Co., Syracuse, N. Y.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., The, Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.
Van Dorn & Dutton Co., Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Cincinnati Gear Co., Cincinnati, Ohio
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fawcus Machine Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., The, Cleveland, O.
Morgan Construction Co., Worcester, Mass.
Morse Williams & Co., Phila., Pa.
Newark Gear Cutting Machine Co., Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa
Philadelphia Gear Works, Philadelphia, Pa.
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Fort Wayne Electric Works, Fort Wayne, Ind.
General Electric Co., New York.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Governors

Pickering Governor Co., The, Portland, Conn.

Graphite

Acheson Graphite Company, International, Niagara Falls, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Felton, Sibley & Co., Phila., Pa.
Obermayer Co., S., Cincinnati, O.

Graphite Grease

Acheson Graphite Company, International, Niagara Falls, N. Y.

Grinders, Bench

Walker & Co., O. S., Worcester, Mass.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cutter

Bath Grinder Co., Fitchburg, Mass.
Becker Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Oesterlein Mach. Co., Cincin., O.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disc

Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Diamond Machine Co., Providence, R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, Ohio.
Taylor & Fenn Co., Hartford, Conn.

Grinders, Drill

Heald Mach. Co., Worcester, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Safety Emery Wheel Co., Springfield, Ohio
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Knife

American Wood Working Mchy. Co., Rochester, N. Y.
Defiance Machine Co., Defiance, O.
Safety Emery Wheel Co., Springfield, O.

Grinders, Portable

Armstrong-Blum Mfg. Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Fortuna Machine Co., New York.
Hisey-Wolf Mach. Co., Cincinnati, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.

Grinders, Tool

Armtrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, O.
Diamond Machine Co., Providence, R. I.
Emmert Mfg. Co., Waynesboro, Pa.
Gisholt Mach. Co., Madison, Wis
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O
Landis Tool Co., Waynesboro, Pa.
LeBlond Machine Tool Co., R. K., Cincinnati, Ohio.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Newark Gear Cutting Machine Co., Newark, N. J.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Oesterlein Mach. Co., Cincin., O.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Tabor Mfg. Co., Phila., Pa.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Walker & Co., O. S., Worcester, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machines

Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Machine Co., Providence, R. I.
Gardner Mach. Co., Beloit, Mich.
Garvin Mach. Co., New York.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
McCabe, J. J., New York.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. & Co., Chicago, Ill.
Safety Emery Wheel Co., Springfield, O.
St. Louis Machine Tool Co., St Louis, Mo.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.

Grinding or Polishing Machines—*Continued.*

Vitrified Wheel Co., Westfield, Mass.

Grinding Wheels

Abrasive Material Co., Philadelphia, Pa.
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Diamond Machine Co., Providence, R. I.
Dickinson, Thos. L., New York.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grindstones and Frames

Cleveland Stone Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.

Gun Barrel Machinery

Diamond Machine Co., Providence R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.

Hammers, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Gould & Eberhardt, Newark, N. J.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Hammers, Electric

Fort Wayne Electric Works, Fort Wayne, Ind.

Hammers, Pneumatic

Bliss Co., E. W., Brooklyn, N. Y.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power

Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Hammers, Steam

Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Fdry. & Mach. Co., Buffalo, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York

Hangers, Shafting

Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Heading Machinery, Cold

Manville Mach. Co., E. J., Waterbury, Conn.

Heaters, Feed Water

Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

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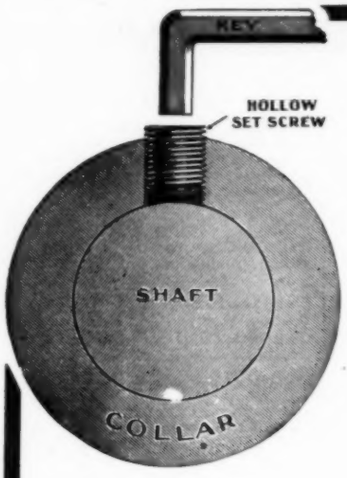
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Hoskins Mfg. Co., Detroit, Mich.
Rockwell Furnace Co., New York.



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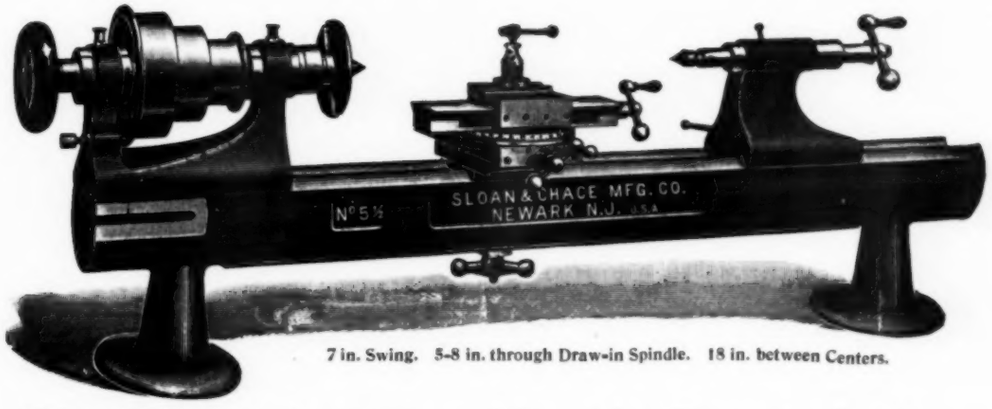

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Newton Machine Tool Wks., Inc., Phila., Pa.
Pratt & Whitney Co., Hartford, Conn.
Schuchardt & Schutte, New York.

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Link Belt Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.
Yale & Towne Mfg. Co., New York.

Hoists, Electric

Browning & Co., Victor R., Cleveland, Ohio.
Cleveland Crane & Engineering Co., Wickliffe, Ohio.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Shaw Electric Crane Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand

Case Mfg. Co., Columbus, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic

Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Hones

Carborundum Co., Niagara Falls, N. Y.

Hose

Sprague Electric Co., New York.

Igniters, Gas Engine

Franklin Mfg. Co., Syracuse, N. Y.

Indicators, Speed

Grant Mfg. & Machine Co., Bridgeport, Conn.
Greene, Tweed & Co., New York.
Veeder Mfg. Co., Hartford, Conn.
Warner Instrument Co., Beloit, Wis.

Indicators, Steam Engine

Crosby Steam Gage & Valve Co., Boston, Mass.

Indicators, Test

Norton Grinding Co., Worcester, Mass.
Starrett Co., L. S., Athol, Mass.

Injectors

Sellers & Co., Inc., Wm., Philadelphia, Pa.

Jacks, Hydraulic

Elmes Engineering Works, Chas. F., Chicago, Ill.
Watson-Stillman Co., New York.

Jacks, Planer

Armstrong Bros. Tool Co., Chicago, Ill.

Kettles, Soda

Brown & Sharpe Mfg. Co., Providence, R. I.
Manufacturing Equipment & Engineering Co., Boston, Mass.

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Davis Machine Co., W. P., Rochester, N. Y.
Lapointe Mach. Tool Co., Hudson, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.

Key Seaters—*Continued.*

McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Morton Manufacturing Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Whitney Mfg. Co., Hartford, Conn.

Keys, Machine

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Conn

Knives, Machine

Coes Wrench Co., Worcester, Mass.
Simonds File Co., Fitchburg, Mass.

Lamps, Arc

General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lathe Attachments

American Tool Works Co., Cin., O.
Bradford Mach. Tool Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
LeBlond Machine Tool Co., R. K., Cincinnati, Ohio.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn
Rivett Lathe Mfg. Co., Boston, Mass.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Lathe Dogs

Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Pratt & Whitney Co., Hartford, Conn.

Lathes

American Tool Works Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, Rockford, Ill.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cincin., O.
Bridgeford Mach. Tool Works, Rochester, N. Y.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Cincinnati Lathe and Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Dreses Machine Tool Co., Cin., O.
Fay Mach. Tool Co., Phila., Pa.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., F. E., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mach. Tool Co., Springfield, O.

Lathes—*Continued.*

Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.
Wormer Mchry. Co., C. C., Detroit, Mich.

Lathes, Automatic Screw Threading

Automatic Machine Co., Bridgeport, Conn.
Fay Machine Tool Co., Phila., Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Lathes, Bench

Blount Co., J. G., Everett, Mass.
Hardinge Bros., Chicago, Ill.
Pearce Co., Fred'k, New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Waltham Machine Works, Waltham, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring

American Wood Working Machry. Co., Rochester, N. Y.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Phila., Pa.

Lathes, Brass

Dreses Mach. Tool Co., Cincin., O.
Garvin Machine Co., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mach. Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, O.

Lathes, Extension

Harrington & Sons Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power

Barnes Co., W. F. & Jno., Rockford, Ill.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Gap

American Tool Wks. Co., Cin., O.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sebastian Lathe Co., Cincin., O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Speed

Blount Co., J. G., Everett, Mass.
Chicago Machine Tool Co., Chicago, Ill.
Grant Mfg. & Machine Co., Bridgeport, Conn.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Sebastian Lathe Co., Cincin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Turret

Foster Machine Co., Elkhart, Ind.

Lathes, Wood

American Wood Working Mchy. Co., Rochester, N. Y.
Barnes Co., W. F. & John, Rockford, Ill.
Defiance Machine Works, Defiance, Ohio.
Prentiss Tool & Supply Co., New York

Levels

Keuffel & Esser Co., Hoboken, N. J
Starrett Co, L. S., Athol, Mass.

Lockers, Clothes

Hart & Cooley Co., New Britain Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equipment & Engineering Co., Boston, Mass.

Lubricants

Acheson Graphite Co., International, Niagara Falls, N. Y.
Besly & Co., Chas. H., Chicago, Ill.
Dixon Crucible Co., Jos., Jersey City, N. J.

Lubricators

Besly & Co., Chas. H., Chicago, Ill.
Gem Mfg. Co., Pittsburg, Pa.
Greene, Tweed & Co., New York.

Machinery Dealers

Besly & Co., Chas. H., Chicago, Ill.
Chandler & Farquhar, Boston, Mass.
Chicago House Wrecking Co., Chicago, Ill.
Garvin Machine Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Lea Equipment Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
McCabe Machine Co., New York.
Motch & Merryweather Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, New York.
Prentiss Tool & Supply Co., New York.
Schuchardt & Schutte, New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchry. Co., C. C., Detroit, Mich.

Machine Shop Work

Barnes Co., Wallace, Bristol, Conn.
National Acme Mfg. Co., Cleveland, O.
Universal Machine Screw Co., Hartford, Conn.

Machinists' Small Tools

Bemis & Call Hardware & Tool Co., Springfield, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, New York.
Pratt & Whitney Co., Hartford, Conn.
Schuchardt & Schutte, New York.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Williams & Co., J. H., Brooklyn, N. Y.

Machinists' Supplies

Besly & Co., Chas. H., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
McCabe, J. J., New York.
Patterson, Gottfried & Hunter, New York.
Osgood, J. L., Buffalo, N. Y.
Schuchardt & Schutte, New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Mandrels, Expanding

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Mandrels, Solid

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
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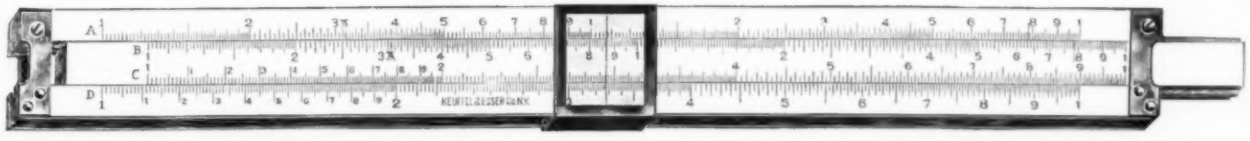

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Lumen Bearing Co., Buffalo, N. Y.
Phosphor Bronze Smelting Co., Phila., Pa.
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Meters, Cut

Warner Instrument Co., Beloit, Wis.

Micrometer Calipers

Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Milling Attachments

Adams Co., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Garvin Mach. Co., New York.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Oesterlein Mach. Co., Cincinnati, Ohio.
Owen Mach. Tool Co., Springfield, Ohio.
Rivett Lathe Mfg. Co., Boston, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Bench

Chicago Machine Tool Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Hand

Adams Co., The, Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Carter & Hakes Machine Co., Winsted, Conn.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Milling Mach. Co., Cincinnati, O.
Garvin Mach. Co., New York.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Horizontal

Adams Co., The, Dubuque, Iowa.
Beaman & Smith Co., Providence, R. I.
Becker Milling Machine Co., Hyde Park, Mass.
Cincinnati Milling Machine Co., Cincinnati, O.
Hendey Mach. Co., Torrington, Conn.
Hess-Bright Mfg. Co., Philadelphia, Pa.
Ingersoll Milling Mach. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Oesterlein Mach. Co., Cincinnati, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Plain

Adams Co., The, Dubuque, Iowa.
American Tool Wks. Co., Cin., O.
Beaman & Smith Co., Prov., R. I.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Carter & Hakes Mach. Co., Winsted, Conn.
Cincinnati Milling Machine Co., Cincinnati, O.

Milling Machines, Plain—*Continued.*

Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morton Manufacturing Co., Muskegon Heights, Mich.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Oesterlein Machine Co., Cin., O.
Owen Mach. Tool Co., Springfield, O
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Universal Boring Machine Co., Hudson, Mass.
Vandyck Churchill Co., New York.
Waltham Watch Tool Co., Springfield, Mass.
Warner & Swasey Co., Cleveland, O.
Whitney Mfg. Co., Hartford, Conn.
Wormer Mchry. Co., C. C., Detroit, Mich.

Milling Machines, Portable

Newton Mach. Tool Works, Inc., Phila., Pa.
Underwood & Co., H. B., Philadelphia, Pa.

Milling Machines, Universal

American Tool Wks. Co., Cin., O.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Carter & Hakes Machine Co., Winsted, Conn.
Cincinnati Milling Machine Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Conn.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Oesterlein Mach. Co., Cincin., O.
Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Vertical

Adams Co., The, Dubuque, Iowa.
Beaman & Smith Co., Prov., R. I.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Carter & Hakes Machine Co., Winsted, Conn.
Clough, R. M., Tolland, Conn.
Garvin Mach. Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Worm

Cleveland Automatic Machine Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.

Milling Tools, Adjustable

Geometric Tool Co., New Haven, Conn.

Mining Machinery

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Ingersoll-Rand Co., New York.

Molding Machines

Adams Co., The, Dubuque, Iowa.
Tabor Mfg. Co., Philadelphia, Pa.

Mortisers

American Wood Working Machry. Co., Rochester, N. Y.

Motors, Electric

Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Cushman Electric Co., Concord, N. H.
Electro Dynamic Co., Bayonne, N. J.
Fort Wayne Electric Works, Fort Wayne, Ind.
General Electric Co., New York.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.
Wagner Electric Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Name Plates

Franklin Mfg. Co., Syracuse, N. Y.

Nippers and Pliers

Utica Drop Forge Co., Utica, N. Y.

Nut Tappers

See Bolt and Nut Machinery.

Odometers

Veeder Mfg. Co., Hartford, Conn.

Oil Cups and Covers

Bay States Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Winkley Co., Detroit, Mich.

Oils

Besly & Co., Chas. H., Chicago, Ill.

Oilers

American Tube & Stamping Co., Bridgeport, Conn.
Bay State Stamping Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Winkley Co., Detroit, Mich.

Oxygen, Welding

Davis-Bournonville Co., New York.

Packings, Hydraulic

Chicago Raw Hide Mfg. Co., Chicago, Ill.

Packing, Smooth-On

Smooth-On Mfg. Co., Jersey City, N. J.

Packing, Steam

Greene, Tweed & Co., New York.

Paints, Machinery

Felton, Sibley Co., Philadelphia, Pa.

Pans, Lathe

Lyon Metallic Mfg. Co., Aurora, Ill.
New Britain Mach. Co., New Britain, Conn.

Pans, Shop

New Britain Mach. Co., New Britain, Conn.

Pattern Shop Tools and Machinery

American Wood Working Machry. Co., Rochester, N. Y.
Baker Bros., Toledo, O.
Blount Co., J. G., Everett, Mass.
Greaves, Klusman & Co., Cin., O.
Defiance Machine Works, Defiance, Ohio.
Hammacher, Schlemmer & Co., New York.
McCabe, J. J., New York.
Prentiss Tool & Supply Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Patterns and Models

Schmidt, F. L., New York.

Phosphor Bronze

Lumen Bearing Co., Buffalo, N. Y.
Phosphor Bronze Smelting Co., Phila., Pa.

Pinion Cutters

Sloan & Chace Mfg. Co., Ltd., Newark, N. J
Stark Tool Co., Waltham, Mass.

Pipe Cutting and Threading Machines

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Landis Machine Co., Waynesboro, Pa.
McCabe, J. J., New York.
Merrell Mfg. Co., Toledo, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Saunders Sons, D., Yonkers, N. Y.
Standard Engineering Works, Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
United Engineering & Foundry Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Pipe Fitters' Tools

Cleveland Twist Drill Co., Cleveland, O.
Reed Mfg. Co., Erie, Pa
Saunders Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.
Williams & Co., J. H., Brooklyn, N. Y.

Planer Attachments

Cincinnati Planer Co., Cincin., O.
Gray Co., G. A., Cincinnati, O.
Reed Co., F. E., Worcester, Mass

Planer Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Planers

American Tool Wks. Co., Cin., O.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Planer Works, Cleveland, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Machine Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Toomey, Frank, Philadelphia, Pa.
Vandyck, Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Planers, Drive

Wheeler Mold Fdry. Co., Wheeling, W. Va.

Planers, Parallel

Walker & Co., O. S., Worcester, Mass.

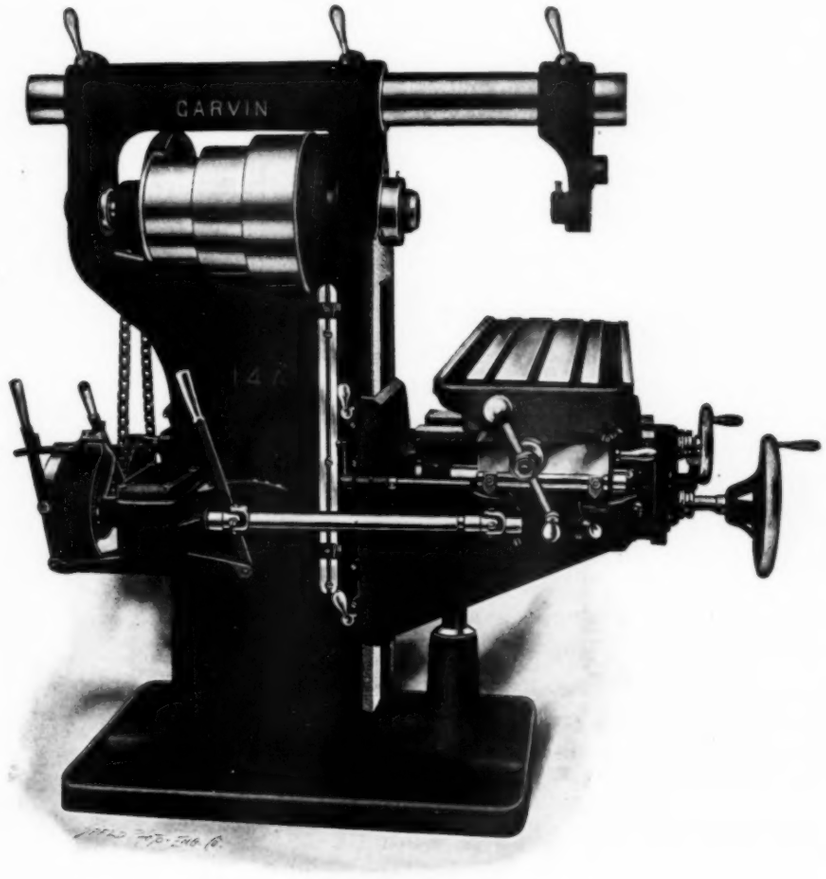
GARVIN No. 14=A (All Feeds)

PLAIN MILLING MACHINE

MOST POWERFUL

SIMPLE AND EFFICIENT MACHINE OF ITS SIZE ON MARKET.

DIRECT CONSTANT FEED MEANS 45% MORE POWER.



Garvin No. 14-A (All Feeds) Plain Milling Machine.

This Machine has Power Feed with reverse and automatic trips in all directions, all controlled by one single handle. We also manufacture the same size machine known as our No. 14 Plain, with power feed only to table.

The letter "A" after any number of a machine means that the machine is provided with power feed and automatic trips in all directions.

Capacity

Table feed	28″
In feed	8″
Up feed	19″
Size of table	48″ x 13½″

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THE GARVIN MACHINE COMPANY,

Spring and Varick Streets, NEW YORK CITY.

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Planers, Portable

Morton Manufacturing Co., Muskegon Heights, Mich.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.

Planers, Rotary

Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Planers, Wood

American Wood Working Mchy. Co., Rochester, N. Y.

Precision Machinery

Remington Tool & Mach. Co., Boston, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Stark Tool Co., Waltham, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Presses, Broaching

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Prentiss Tool & Supply Co., New York.
Watson-Stillman Co., New York.

Presses, Drop

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Niles-Bement-Pond Co., New York.

Presses, Foot and Hand

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Manville Bros. Co., Waterbury, Conn.
Manville Mach. Co., E. J., Waterbury, Conn.
Taylor & Fenn Co., Hartford, Conn.

Presses, Forging

Bliss Co., E. W., Brooklyn, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Consolidated Press and Tool Co., Hastings, Mich.
Niles-Bement-Pond Co., New York.

Presses, Hydraulic

Chambersburg Engineering Co., Chamberburg, Pa.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Watson-Stillman Co., New York.

Presses, Power

Automatic Machine Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Dill Slotter People, Philadelphia, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Manville Bros. Co., Waterbury, Conn.
Manville Mach. Co., E. J., Waterbu.y, Conn.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Springfield Machine Tool Co., Springfield, O.

Presses, Power Forcing

Barnes Co., W. F. & John, Rockford, Ill.
Lucas Machine Tool Co., Cleveland, Ohio.

Presses, Screw

Barnes Co , W. F. & John, Rockford, Ill.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.

Profilers

Becker Milling Machine Co., Hyde Park, Mass.
Garvin Machine Co., New York.
Newton Machine Tool Wks., Inc., Phila., Pa.
Pratt & Whitney Co., Hartford, Conn.

Publishers

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.

Pulleys

American Pulley Co., Phila., Pa.
Caldwell & Son Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
McCabe, J. J., New York.
Moore & White Co., Phila., Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, New York.
Reeves Pulley Co., Columbus, Ind.
Rockwood Mfg. Co., Indianapolis, Ind.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Wilmarth & Morman Co., Grand Rapids, Mich.

Pulleys, Paper

Rockwood Mfg. Co., Indianapolis, Ind.

Pulley Turning and Boring Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.

Pumps, Electric

General Electric Co., New York.

Pumps, Hydraulic

Elmes Engineering Works, Chas. F., Chicago, Ill.
General Electric Co., New York.
Watson-Stillman Co., New York.

Pumps, Pneumatic

Chambersburg Engineering Co., Chambersburg, Pa.
Ingersoll-Rand Co., New York.

Pumps, Steam

Clayton Air Compressor Works, New York.
Ingersoll-Rand Co., New York.

Punches, Centering

Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Sellers & Co., Inc., Wm., Phila., Pa.
Starrett Co., L. S., Athol, Mass.

Punches, Hand

Armstrong-Blum Mfg. Co., Chicago, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Punches, Hydraulic

Chambersburg Engineering Co., Chambersburg, Pa.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Foundry Co., Pittsburg, Pa.
Watson-Stillman Co., New York.

Punches, Power

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Long & Allstatter Co., Hamilton, Ohio.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Royersford Foundry & Mach. Co., Royersford, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Foundry Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.

Pyrometers, Electric

Bristol Co., Waterbury, Conn.
Hoskins Mfg. Co., Detroit, Mich.

Racks, Cut

Boston Gear Works, Norfolk Downs, Mass.

Racks, Cut —*Continued.*

Fellows Gear Shaper Co., Springfield, Vt.
Flather Mfg. Co., E. J., Nashua, N. H.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Newark Gear Cutting Machine Co., Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Woburn Gear Works, Woburn, Mass.

Rack Cutting Machines

Adams Co., The, Dubuque, Ia.
Fellows Gear Shaper Co., Springfield, Vt.
Flather Mfg. Co., E. J., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, Ohio.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.
Schuchardt & Schutte, New York.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Racks, Tool

Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equipment & Engineering Co., Boston, Mass.
New Britain Mach. Co., New Britain, Conn.

Radiators, Japanning Oven

American Gas Furnace Co., New York.

Reamers

Boker & Co., Hermann, New York.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Clough, R. M., Tolland, Conn.
Gisholt Mach. Co., Madison, Wis.
Hart Mfg. Co., The, Cleveland, O.
Lapointe Mach. Tool Co., Hudson, Mass.
Meyer Reamer Co., Cleveland, Ohio.
Morse Twist Drill & Mach Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Smith Co., Wm. J., New Haven, Conn.
Standard Tool Co., Cleveland, O.
Ward & Son, Edgar T., Boston, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Electric

Van Dorn Elec. Mfg. Co., Cleveland, Ohio.

Reaming Stands

Flather Planer Co., Mark, Nashua, N. H.
Skinner Chuck Co., New Britain, Conn.

Recorders, Speed

Warner Instrument Co., Beloit, Wis.

Rheostats

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Riveters, Hydraulic

Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Riveters, Pneumatic

Bliss Co., E. W., Brooklyn, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill
Ingersoll-Rand Co., New York
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Riveters, Steam

Sellers & Co., Inc., Wm., Philadelphia, Pa.

Rivet Making Machinery

Manville Machine Co., E. J., Waterbury, Conn.

Riveting Machines

Chambersburg Engineering Co., Chambersburg, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Long & Allstatter Co., Hamilton, Ohio.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Townsend Mfg Co., H. P., Hartford, Conn.

Rolling Mill Machinery

Dill Slotter People, Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.

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Cling-Surface Co., Buffalo, N. Y.

Rules, Steel

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Boston Saw and Tool Co., Boston, Mass.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Hammacher, Schlemmer & Co., New York.
Huther Bros. Saw Mfg. Co., Rochester, N. Y.
Massachusetts Saw Works, Chicopee, Mass.
Patterson, Gottfried & Hunter, New York.
Simonds File Co., Fitchburg, Mass.
Starrett Co., L. S., Athol, Mass.
West Haven Mfg. Co., New Haven, Conn.

Sawing Machines, Metal

Cochrane Bly Co., Rochester, N. Y.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Gorton Machine Co., Geo., Racine Wis.
Lea Equipment Co., New York.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Simplex Mfg. Co., Philadelphia, Pa.
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Union Twist Drill Co., Athol, Mass.
Vandyck Churchill Co., New York.
United Engineering & Fdry. Co. Pittsburg, Pa.
West Haven Mfg. Co., New Haven, Conn.

Sawing Machines, Wood

American Wood Working Mchy. Co., Rochester, N. Y.
Colburn Mach. Tool Co., Franklin, Pa.
Greaves, Klusman & Co., Cin., O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Saws, Metal Band

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
West Haven Mfg. Co., New Haven, Conn.

Saws, Power Hack

Armstrong-Blum Mfg. Co., Chicago, Ill.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Hoefer Mfg. Co., Freeport, Ill.
Niles-Bement-Pond Co., New York
West Haven Mfg. Co., New Haven, Conn.

Saws, Screw Slotting

Simonds File Co., Fitchburg, Mass.

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Dreses Mach. Tool Co., Cincin., O.
Foster Mach. Co., Elkhart, Ind.
Garvin Mach. Co., New York.
Marshall & Huschart Machinery Co., Chicago, Ill.
National-Acme Mfg. Co., Cleveland O.
Pratt & Whitney Co., Hartford Conn.
Prentice & Co., Geo. G., Inc., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Universal Machine Screw Co., Hartford, Conn.
Windsor Mach. Co., Windsor, Vt.
Wood Turret Mach. Co., Terre Haute, Ind.

Screw Machines, Hand

Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Mach. Co., Cleveland, O.
Garvin Machine Co., New York.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.
Warner & Swasey Co., Cleveland, O.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.
Wood Turret Mach. Co., Terre Haute, Ind.

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Cook Co., Asa S., Hartford, Conn.

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Besly & Co., Chas. H., Chicago, Ill.
Brubaker & Bros., W. L., Millersburg, Pa.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtuckett, R. I.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Screws, Cap and Set

Hammacher, Schlemmer & Co., New York.
Electric Welding Products Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O
Worcester Machine Screw Co., Worcester, Mass.

Screws, Machine

Chicago House Wrecking Co., Chicago, Ill.
Electric Welding Products Co., Cleveland, Ohio.
Hammacher, Schlemmer & Co., New York.
National-Acme Mfg. Co., Cleveland, O.
Standard Gauge Steel Co., Beaver Falls, Pa.
Universal Machine Screw Co., Hartford, Conn.
Worcester Machine Screw Co., Worcester, Mass.

Second Hand Machinery

American Tool Works Co., Cin., O.
Chandler & Farquhar, Boston, Mass.
Chicago House Wrecking Co., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Garvin Machine Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
McCabe, J. J., New York.
Motch & Merryweather Machy. Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Second Hand Machinery —*Continued.*

Toomey, Frank, Philadelphia, Pa.
Wormer Machry. Co., C. C., Detroit, Mich.

Separators, Oil and Steam

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Shafting, Steel

Cumberland Steel Co., Cumberland, Md.

Shapers

American Tool Works Co., Cin., O.
Cincinnati Shaper Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Flather Planer Co., Mark, Nashua, N. H.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Juengst & Sons, Geo., Croton Falls, N. Y.
Kelly Mach. Co., R. A., Xenia, O.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machinery Co., Chicago, Ill.
McCabe, J. J., New York.
Morton Manufacturing Co., Muskegon Heights, Mich.
Motch & Merryweather Co., Cleveland, Ohio.
Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith & Mills, Cincinnati, O.
Springfield Machine Tool Co., Springfield, O.
Steptoe Shaper Co., John, Cincinnati, Ohio.
Vandyck Churchill Co., New York.
Walcott & Wood Machine Tool Co., Jackson, Mich.

Shapers, Wood

American Wood Working Machry. Co., Rochester, Pa.

Shears, Hand

Armstrong-Blum Mfg. Co., Chicago, Ill.

Shears, Power

Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Mach. Co., Bridgeton, N. J.
Long & Allstatter Co., Hamilton, O.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Royersford Foundry & Mach. Co., Royersford, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Wheeling Mold Fdry. Co., Wheeling, W. Va.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Shears, Rotary

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
United Engineering & Fdry Co., Pittsburg, Pa.

Sheets

Phosphor Bronze Smelting Co., Philadelphia, Pa.

Sheet Metal Working Machinery

Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Machine Co., Bridgeton, N. J.

Slide Rests

Betts Mach. Co., Wilmington, Del.
Blount Co., J. G., Everett, Mass.
Garvin Machine Co., New York.
National Acme Mfg. Co., Cleveland, O.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Reed Co., F. E., Worcester, Mass.

Slotters

Baker Bros., Toledo, O.
Betts Mach. Co., Wilmington, Del.
Dill Slotter People, Philadelphia, Pa.
Garvin Machine Co., New York.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Slotters, Auto Screw

Garvin Mach. Co., New York.
Manville Mach. Co., E. J., Waterbury, Conn.
Taylor & Fenn Co., Hartford, Conn.

Slotters, Portable

Newton Machine Tool Wks., Inc., Phila., Pa.

Sockets and Sleeves

American Specialty Co., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.

Speed Changes

Moore & White Co., Philadelphia, Pa.

Special Machinery and Tools

Automatic Mach. Co., Bridgeport, Conn.
Beaman & Smith Co., Prov., R. I.
Bilgram Machine Works, The, Philadelphia, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Blanchard Machine Co., Cambridge, Mass.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Electric Welding Products Co., Cleveland, Ohio.
Fawcus Mach. Co., Pittsburg, Pa.
Foster Machine Co., Elkhart, Ind.
Garvin Mach. Co., New York.
Hoefer Mfg. Co., Freeport, Ill.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Lucas Mach. Tool Co., Cleveland, Ohio.
Manning, Maxwell & Moore, Inc., New York.
Merritt, Jos., Hartford, Conn.
Morrow Mfg. Co., Elmira, N. Y.
Mueller Mach. Tool Co., Cin., O.
Owen Mach. Tool Co., Springfield, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Risdon Tool Works, Inc., Waterbury, Conn.
Rowbottom Machine Co., Waterbury, Conn.
Schaeffer Machine Wks., Philadelphia, Pa.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Spacke Mach. Co., W. F., Indianapolis, Ind.
Standard Engineering Works, Ellwood City, Pa.
Taylor & Fenn Co., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.

Spring Winders

Remington Tool & Mach. Co., Boston, Mass.

Springs

Barnes Co., Wallace, Bristol, Conn.

Sprocket Chains

Bilgram Machine Works, The, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Link-Belt Co., Philadelphia, Pa.
Whitney Mfg. Co., Hartford, Ct.
Woburn Gear Wks., Woburn, Mass.

Stampings, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bay Stamping Co., Worcester, Mass.
Risdon Tool Works, Inc., Waterbury, Conn.
Stearns Stamping Co., W. H., Worcester, Mass.

Stamps, Steel

Hoggson & Pettis Mfg. Co., New Haven, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

Steam Specialties

Crosby Steam Gage & Valve Co., Boston, Mass.

Steel, Air Hardening

Boker & Co., Hermann, New York.
Firth-Sterling Steel Co., McKeesport, Pa.

Steel, Bar

Philadelphia Steel & Forge Co., New York.

Steel Machinery

Boker & Co., Hermann, New York.
Firth-Sterling Steel Co., McKeesport, Pa.
Heller Bros. Co., Newark, N. J.
Standard Gauge Steel Co., Beaver Falls, Pa.
Ward & Son, Edgar T., Boston, Mass.

Steel, Sheet

American Tube & Stamping Co., Bridgeport, Conn.
Firth-Sterling Steel Co., McKeesport, Pa.
Simonds File Co., Fitchburg, Mass.
Ward & Son, Edgar T., Boston, Mass.

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American Tube & Stamping Co., Bridgeport, Conn.
Boker & Co., Hermann, New York.
Firth-Sterling Steel Co., McKeesport, Pa.
Heller Bros. Co., Newark, N. J.
Standard Gauge Steel Co., Beaver Falls, Pa.
Ward & Son, Edgar T., Boston, Mass.

Stocks, Die

See Taps and Dies.

Stones, Oil

American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.
Vitrified Wheel Co., Westfield, Mass.

Stools, Shop

Manufacturing Equipment and Engineering Co., Boston, Mass.
New Britain Machine Co., New Britain, Conn.

Straightening Machinery

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-PondCo., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Springfield Machine Tool Co., Springfield, O.
United Engineering & Fdry. Co., Pittsburg, Pa.

Straighteners, Hydraulic

Niles-Bement-Pond Co., New York.

Swaging Machines

Excelsior Needle Co., Torrington, Conn.

Switchboards

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Garwood Electric Co., Garwood, N. J.
Wagner Electric Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Veeder Mfg. Co., Hartford, Conn.

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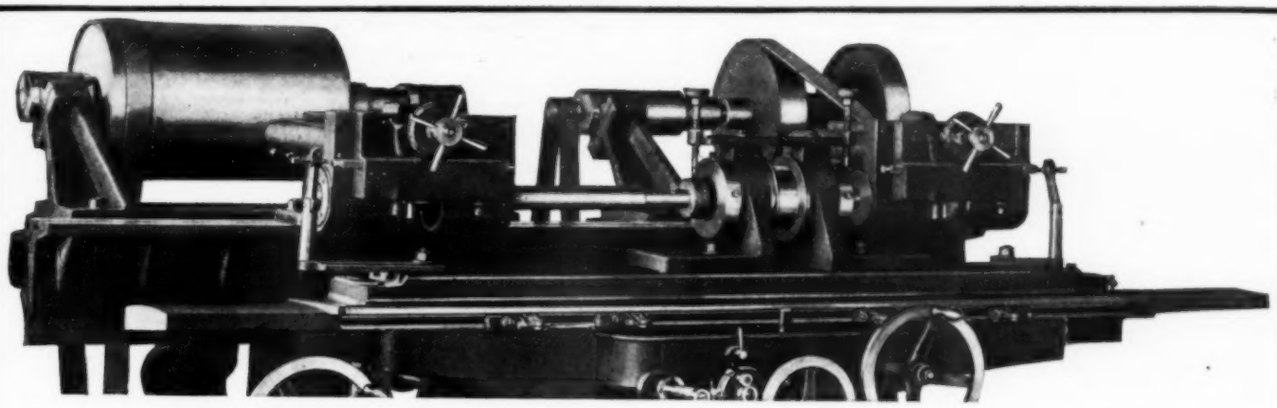
Keuffel & Esser Co., Hoboken, N. J.
Starrett Co., L. S., Athol, Mass.



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Fosdick Mach. Tool Co., Cincinnati, O.
Garvin Mach. Co., New York.
Geometric Tool Co., New Haven, Conn.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
St. Louis Machine Tool Co., St. Louis, Mo.
Whitney Mfg. Co., Hartford, Conn.

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Boker & Co., Hermann, New York.
Brubaker & Bros., W. L., Millersburg, Pa.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Foote-Burt Co., Cleveland, Ohio.
Geometric Tool Co., New Haven, Conn.
Hammacher, Schlemmer & Co., New York.
Hardinge Bros., Chicago, Ill.
Hart Mfg. Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Pratt & Whitney Co., Hartford, Conn.
Saunders' Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.
Ward & Sons, Edgar T., Boston, Mass.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Taps, Collapsing

Geometric Tool Co., New Haven, Conn.

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Sellers & Co., Inc., Wm., Philadelphia, Pa.

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Besly & Co., Chas. H., Chicago, Ill.
Foote-Burt Co., Cleveland, O.
Hart Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Ready Tool Co., The, New Haven, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.

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Manville Mach. Co., E. J., Waterbury, Conn.

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Cleveland Twist Drill Co., Cleveland, O.
Hammacher, Schlemmer & Co., New York.
Krieger Tool Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Osgood, J. L., Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Ready Tool Co., The, New Haven, Conn.

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See Machinists' Small Tools.

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Tubing, Seamless Steel

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Standard Welding Co., Cleveland, O.
Ward & Son, Edgar T., Boston, Mass.

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Davis Machine Co., W. P., Rochester, Pa.
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Fay Mach. Tool Co., Phila., Pa.
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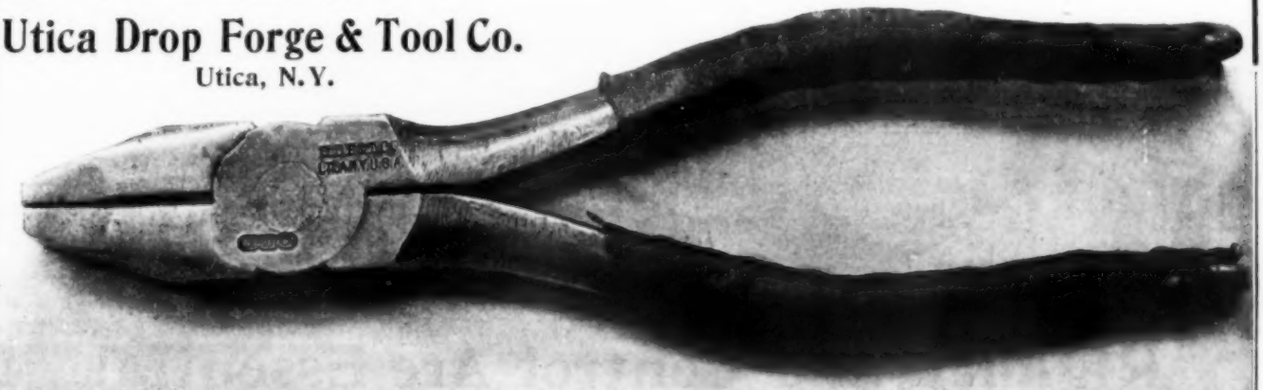

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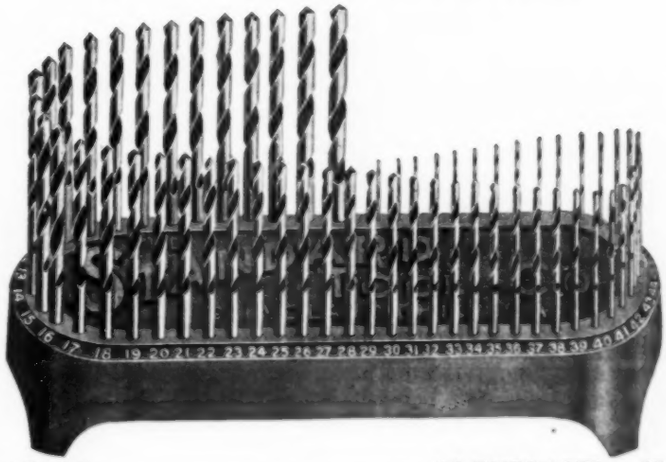

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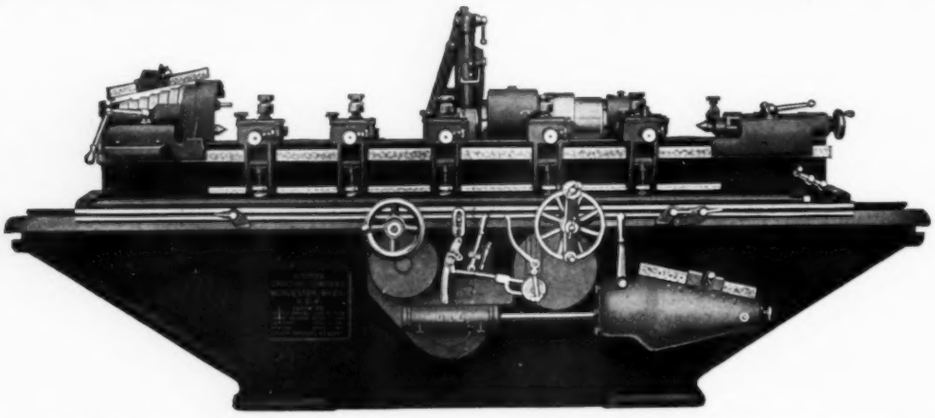

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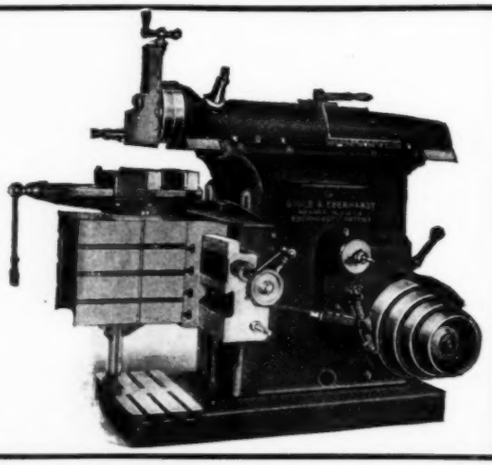

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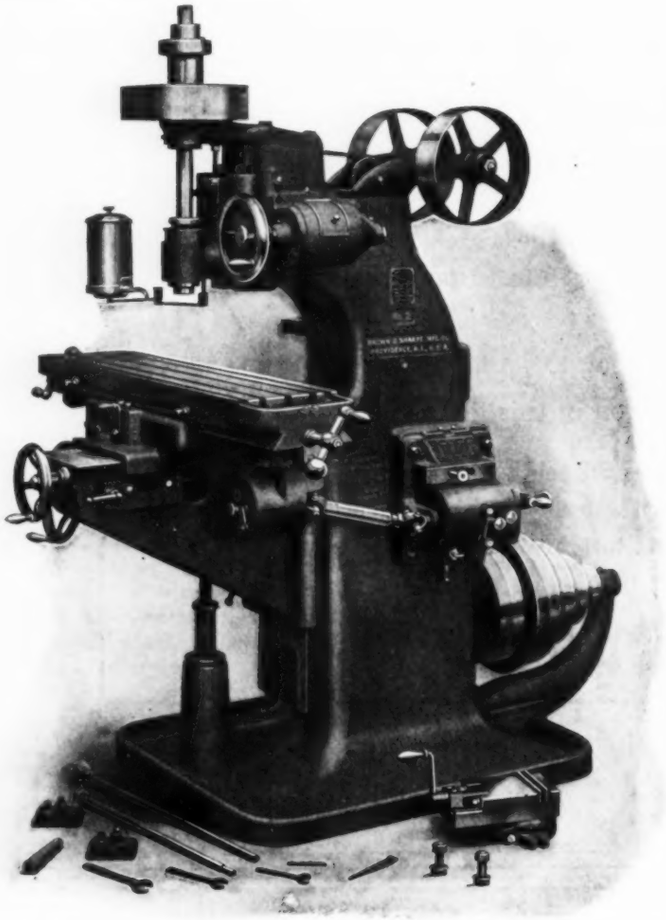

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Accurate High Speed Light Milling

WHEN profiling, cutting irregular slots, face milling or doing a large variety of other light work the

No. 2 Vertical Spindle Milling Machine

is preferable to the horizontal spindle machine.

A range of available spindle speeds, varying from 80 to 1000 R.P.M. in one direction and from 97 to 848 R.P.M. in the opposite direction, together with a correspondingly wide range of feeds, particularly adapts this machine to the rapid and extremely accurate production of all classes of work for which it was designed.

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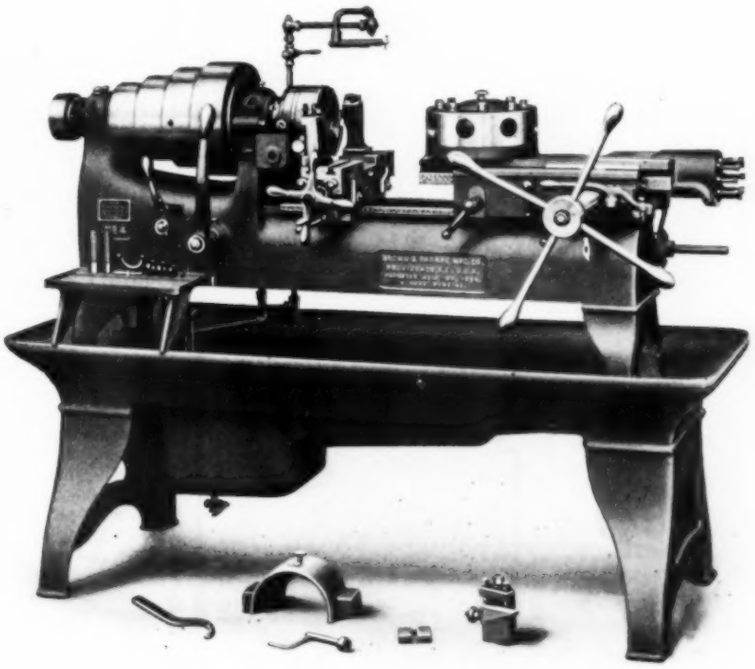
The Turret of the No. 4 Wire Feed Screw Machine

contains 8 holes in which to clamp tools and therefore permits the use of tools of simple construction.

Another feature of the turret of this machine is the automatic clamping device which securely locks the turret when a tool is brought into the correct position.

An independent automatic stop for each hole in the turret obviates the setting of tools to exact distances in the turret as the movement of each tool can be controlled by its own stop.

The feed is of the roller type and is located in the front end of the cone as near the chuck as possible in order that short lengths of stock may be fed.



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Capacity:

Swing over bed, 15¼″; over cross slide, 7″. Hole through, 1 5/16″. Diameter of stock, 1¼″. Length that can be turned, 8″.

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PLANERS	48"x48"x14' four heads, "Sellers" 48"x38"x12' two " "Cincinnati" 42"x42"x18' two " "Niles" 32"x32"x10' two " "Pond" 27"x27"x 6' one " "Ohio" 24"x24"x 5' one " "Whitcomb"
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24 in. x 12 ft. Sherman
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16 in. x 6 ft. Pratt & Whitney
12 in. x 5 ft. Fairbanks
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60 in. Stevens Pulley Lathe
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No. 4 W. & S. Turret Screw
No. 1 Bardons & O. Wire Feed

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10 in. Stover Sens
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11 in. Norton-Jones Sens
20 in. Davis, Bk. Gd., P. F.
26 in. New Haven, Bk. Gd.
24 in. Bickford, Bk. Gd.
22 in. Bk. Gd. P. F.
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2⅜ ft. arm Morris, with T. A.
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22 in. Walcott Gd. Back
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15 in. Hendey, with swivel vise
16 in. Steptoe

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Special 2-sp. Geared
No. 7 Becker-B. Lincoln
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Cincinnati Pl. Cutter & Reamer
No. 6 Gardner Dbl. Disc
36 in. Diamond Roll
Pratt & W. Cutter
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34 in. King, sgl. hd. Vert.
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MISCELLANEOUS

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Keyseater, No. 2 Baker Bros.
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11x 4' Blount speed, with slide rest.
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18x 8' Fish, P. C. F., hollow spindle.
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22x12' Lodge & Shipley, patent geared head.
24x14' Lodge & Shipley, triple geared.
26x26' Niles, C. R., P. C. F.
30x14' Putnam, C. R., P. C. F.
36x15' Lathe & Morse, C. R., P. C. F.
102x35' Bement, triple geared, C. R., P. C. F.

SCREW MACHINES AND MONITORS.

1" Warner & Swasey, W. F.
1½" Garvin, wire feed, friction back-geared hd.
No. 2½—1¼" Pratt & Whitney, wire feed.
24" American turret lathe.
Brown & Sharpe semi-automatic wire feed.
⅜"—⅝"—1"—2¼" Cleveland full automatics.
21" and 24" Gisholt, turret machines, motor driven.

MILLERS.

No. 3½ Fox, hand and power.
No. 0 Van Norman, Duplex.
No. 2 Pratt & Whitney, hand.
No. 1 Cincinnati, plain belt feed.
No. 9 Kempsmith, plain, 36" feed.
No. 22 Brainard, plain, 45" feed.
No. 7 Becker-Brainard, Lincoln pattern.
22"x22"x6' Ingersoll, slab.
36"x10' Pratt & Whitney, slab.

DRILLS.

2-sp. Henry & Wright, sensitive.
20" Rockford, back gears, power feed.
36" Hamilton, sliding head, back geared.
48" Baush, plain radial, tapping attachment.
60" Niles, full universal, tapping attachment.
72" Universal radial.

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24" Hendey friction.
28" Prentiss friction.

PLANERS.

16x16x 4' Hendey, one head.
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32x32x 8' Pease, one head.
36x36x 8' Mark Flather, two heads.
60x60x12' Sellers, four heads.
81x54x16' Betts, one head.

MISCELLANEOUS

7 B Jarecki Pipe Machine, 3".
¼" Schuster Riveter.
No. 1 Garvin vertical tapper.
No. 20 Bliss inclinable press.
No. 5 Bliss double crank press.
4-spindle National nut tapper.
No. 5B Mossburg & Granville geared press.
38" McCabe vertical boring mill, one head.
18" and 26" Brown & Sharpe gear cutters.
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1100 lb. Pratt & Whitney drop hammer.
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Located at Boston, Chicago and New York.

LATHES.

7"x32" Bench P. & W., Thread Att.
7"x32" P. & W. Plain.
12"x5' R. & F. LeBlond.
16"x6' R. & F. Flather.
16"x6' C. R. Flather.
16"x6' C. R. Prentice.
16"x6' C. R. & T. Fitchburg.
16"x6' C. R. Putnam motor drive.
16"x8' Taper, Reed.
18"x8' Plain R., Flather.
18"x8' C. R. Putnam, motor drive.
18"x10' Geared Hd. Draper.
22"x16' Shafting Lathe, Fitchburg.
24"x8' C. R. Putnam, not screw cutting.
24"x12' C. R. Putnam motor drive.
28"x15' C. R. Blaisdell raising blocks to 36"
30"x12' C. R. and Taper, Johnson Tri. Gd.
48"x10' Plain Engine Lathe.
50"x30' C. R. Pond Tri. Gd.
13" Gisholt Turret Lathe.
24" American Turret Lathe.
28" Gisholt Turret Lathe.

MILLING MACHINES.

No. 00 Bench, P. & W.
Brainard Index Miller.
No. 0 Plain.
No. 2 Plain Garvin.
No. 3 Plain Garvin.
No. 4½ Plain Becker.
No. 4 Plain B. & S., old style.
No. 1 Universal LeBlond.
No. 4 Universal B. & S., old style.
No. 2 Lincoln, P. & W.
No. 5 Vertical Becker.
No. 2 Profiler Garvin.

RAILROAD MACHINERY.

Bement Single Axle Lathe.
Bement Double Axle Lathe.
No. 2 Niles Double Axle Lathe, belt or motor.
No. 3 Putnam extra heavy Axle Lathe.
36" Baker Car Wheel Borer.
300-ton 48" Niles Wheel Press.

SHAPERS AND PLANERS.

12" Crank, Springfield.
20" Friction, Hendy.
18" Double Trav. Td., Cincinnati.
17"x17"x4' Whitcomb Planer.
24"x24"x6' Putnam, motor.
26"x26"x6' Pond.
30"x30"x24' 2 Hds., Sellers.
42"x42"x10' 4 Hds., Pond Machine Tool.
48"x48"x9' 1 Hd., Hewes & Phillips.
72"x72"x24' 3 Hds., Bement.
72"x72"x24' 3 Hds., Sellers.

BORING MILLS.

34" Colburn Turret Borer.
36" B. & S., Turret Borer.
37" Vertical 2 Hds., Bullard.
21' Vertical 3 Hds., Pond, motor.
96" Swing, Special Hor. Bor. Mill.

TURRET MACHINERY.

¼" No. 00 Garvin Wire Feed.
½" No. 1 P. & W. Wire Feed.
⅝" No. 2 P. & W. Wire Feed.
1¾" No. 3 B. & O., Wire Feed, Gd. Hd.
2" No. 3 P. & W. Wire Feed, Gd. Hd.
¼" No. 0 Hartford Automatic Pin Machine.
¼" Cleveland Automatic Pin Machine.
¼" No. 00 Hartford P. & W., Auto. Pin Mach.
5/16" No. 0 P. & W. 2-Sp. Auto. Pin Mach.
⅜" No 1 Acme old style, 4-Sp. Auto. Pin Mach.
21/32" No. 2 old style B. & S. Auto. Pin Mach.
½" No. 1 P. & W., 2-Sp. Auto.
½" No. 1 Spencer Single Turret.
½" No. 1 Spencer Double Turret.
⅝" No. 2 P. & W., Automatic.
1" No. 2 Hartford Automatic.
1¾" No. 3-A P. & W., Automatic.

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30" Draw-stroke Slotter, Baker Bros.
No. 6 Bulldozer, Williams-White.
No. 2 Cutter Grinder, B. & S.
5' 6" Radial Drill, Niles.
Single Spindle Drills.
Multiple Spindle Drills.
14' Arm Cleveland Wall Radial Drill.
¼" capacity 10 spindle adjustable Drill.
1½" capacity 10 spindle adjustable Drill.

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30" Bullard, 3-jaw chuck
36" Niles
51" Bullard, two heads
82" Industrial, one head
F. K. Miles Horizontal, 2¼" bar

DRILLS

9" Bench
10" Barnes Friction, chuck
23" Hoefer Sta. hd., b.g., chuck
24" Bickford sliding head
28" Aurora, sliding head
Four-spindle Redington Sensitive
20" Barnes, six spindle, mfrs. type
3' Hilbert pl. radial, gear box, tap.
4' Niles, plain radial
3' Economic, belt drive, tap. at.

GRINDERS

Ransom Water Tool
Style A new Yankee
No. 1 Oesterlein, tool room
No. Landis plain

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14"x 6' Reed, r. & f.r., h.s.
14"x 6' Flather, p.r., h.s.
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15"x 6' Von Wyck, c.r., h.s., q.c.g
17"x 8' Greaves & Klus., c.r., h.s.
22"x 8' Blaisdell, p.r., chuck
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24"x10' Hendy, c.r., h.s., q.c.g.
24"x10' Fitchburg, solid spindle, c.r., chuck
26"x10' Pond, solid spindle, p.r.
26"x10' Davis, h.s., c.r. new
31"x16' Bradford, raising blocks 42", chuck and taper
32"x10' Gleason, p.r., chuck
32"x10' Gleason, raising blocks 36", p.r., chuck
33"x10' Fitchburg, h.s., c.r., new

TURRET LATHES AND SCREW MACHINES

No. 3 Bardons & Oliver, fric. hd.
42" New Haven
Potter & Johnson Automatic
24" Bullard Horiz., taper attach.
1" Pratt & Whitney, wire feed
¾" Garvin, wire feed
1" Cleveland Automatic, complete
¾" Cleveland Automatic, complete
Four-spindle National Acme

MILLING MACHINES

No. 1 Cincinnati, universal
No. 3 Becker-Brainerd, universal
No. 12 Brown & Sharpe, universal
No. 24 Becker-Brainerd, plain
No. 16 Kempsmith, plain, with vert. attach.
No. 34 Oesterlein, plain
No. 6 Grant, Lincoln type

SHAPERS AND PLANERS

6" Boynton & Plummer
16" Lodge & Davis
22" Gould & Eberhardt
24" Walcott
16" Potter & Johnson, swivel table
25" Steptoe
24"x24"x 5' Gray, one head
28"x28"x 8' Rockford, one hd., new
30"x30"x14' Amer., two hds., reblt.
36"x36"x10' Pratt & Whit., one hd.
40"x40"x10' Pratt & Whit., two hds.

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Bolt Cutter, 4" National
Bement Axle Cut-off Lathe, dbl. hd.
Gear Cutter, 50" Gould & Eber., spurs and bevels
Gear Cutter, 33"x9" Gould & Eber.
Hammer, 1100 lb. board drop
Keyseater, No. 00 Baker
Keyseater, No. 1 Davis
Keyseater, No. 3 Burr, vert. attch.
Fitchburg Low Swing Lathe
Pipe machine, 6" Camden
Profiler, No. 3 Garvin
Tube Cutter, Fox

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Refitted Machine Tools

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1-37" Bridgeport—one head

CENTERING MACHINE

1-5" D. E. Whiton 2-spindle

DRILL PRESSES

1- Dallet Portable
1-6-spindle Quint turret
1-33" Bement-Miles

DRILL PRESSES—Radial

1-42" Dreses Radial
1-42" Dreses Radial

GEAR CUTTERS

1-Grant-Lees Hobbing Machine
1-30"x8" Brainard Spur
1-36"x9"x4p-Gould & Eberhardt
1-38x9x6p Gould & Eberhardt
1-48"x10x3p Gould & Eberhardt
2-50"x11"x3-p Gould & Eberhardt

GRINDERS

1-"A" Yankee Drill Grinder
1-PO Yankee Drill Grinder
1-Leland & Faulconer wet

HAMMERS

1-60 lb. Bradley, cushion helve

LATHES

1-14"x5' Windsor, fric. counters'ft
1-14"x6' LeBlond, qk.ch. gear
1-14"x8' Flather
1-16"x6' Reed, belt fd., plain rest
1-16"x6' Lodge & Shipley, qk.ch. gear
1-18"x6' Lodge & Shipley, qk.ch. gear
2-20"x8' Flather, compound rest
1-22"x10' Lodge & Shipley, qk.ch. gear
2-22"x12' Lodge & Shipley, qk.ch. gear
1-22"x12' Walcott
1-24"x10' Lodge & Barker
1-24"x12' Lodge & Shipley, qk.ch. gear
1-24"x16' Lodge & Shipley, qk.ch. gear
1-26"x12' Reed
1-27"x14' Lodge & Shipley, qk.ch. gear

LATHES—Polishing

1-No. 3 Diamond, 52x1¼ spindle
1-No. 7G Diamond, 46x1¼ spindle

MILLING MACHINES

1-No. 3 Cincinnati plain, all feeds
1-No. 4 Cincinnati, all feeds, plain
1-42"x24"x8' Ingersoll, slab

PLANERS

1-10" Bush Crank
1-20"x20"x4' Wheeler, 1 head
1-33"x33"x8' Cincinnati, 2 head
1-36"x36"x8' Cincinnati, 2 heads
1-36"x36"x8' Cincinnati, 2 heads, variable feed box
1-36"x36"x8' Detrick & Harvey, 3 heads, supplemental rolling table
1-36"x36"x10' Gray, one head
1-42"x36"x14' Cincinnati, 2 heads
1-42"x36"x8' Cincinnati, 2 heads

PRESSES

2-No. 20 Bliss
1-DG No. 4 Ferracute
1-No. 63 Toledo
1-No. 8 Greenerd arbor

SAWS

1-5½" Burr
1-6" Newton
1-Millers-Falls Hack
1-26" Crescent band

SHAPERS

1-14" Lodge & Davis
1-16" Gould & Eberhardt
1-18" Steptoe
1-20" Hendey
1-24" Gould & Eberhardt
1-24" Hendey
1-24" Potter & Johnston
1-26" Cincinnati, triple geared
1-28" Hendey
1-32" Gould & Eberhardt
1-34" Walcott, shifting belt

TURRET LATHES

1-No. 5 Warner & Swasey
1-28" Bullard "H" Machine
1-26" Universal, chuck fitted

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3—40 in. x 18 ft. Compound Triple Geared Engines
40 in. x 24½ ft. Pond
36 in. x 12 ft. Putnam
30 in. x 20 ft. Pond
24 in. x 12 ft. Flather
30 in. x 16 ft. New Haven Lathe
27 in. x 20 ft. Bement

PLANERS
84 in. x 84 in. x 27 ft. Lowell, 2 Heads
84 in. x 84 in. x 24 ft. Putnam, 1 Head
36 in. x 14 ft. Detrich & Harvey Open Side, 3 Heads
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1000 lb. Chambersburg Steam Drop
800 lb. Pratt & Whitney Board Drop
250 lb. Morgan Single Frame Steam Hammer

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16 in. Back Geared Cincinnati
16 in. Ohio

SPECIAL
30 in. Bullard Turret Head Boring Mill
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10 ft. Vertical Boring Mill, 2 Heads
8 ft. " " " 2 "
4 ft. " " " 2 "

These are modern up-to-date Mills.

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1—36x16 Walbum & Swenson Lathe
1—36x14 Dietz, Schumacher & Boye Lathe
1—26x14 Blaisdell Lathe
2—16x8 Putnam Lathe
1—16x6 Perkins Lathe
1—14x8 Flather Lathe

PLANERS
1—60x60x16 ft. Betts (3 Heads)
1—48x48x10 ft. Hughes & Phillips (2 Heads)
1—54x54x23 ft. Niles (4 Heads)
1—32x32x5 ft. New Haven
1—16x16x4 ft. New Haven

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1—6 ft. Universal Radial, Universal Drill Co.
1—4½ ft. Plain Radial, Universal Drill Co.
1—5 ft. Bickford Universal Drill
1—3½ ft. Radial Drill, Universal Table

BORING MILLS
1—10 ft. Betts 2 Swivel Heads, almost new
1—10 ft. Betts, Walbum & Swenson, 2 sw. Hds.
1—36 in. Boring Mill, 1 swivel head
1—Turret Head Bullard

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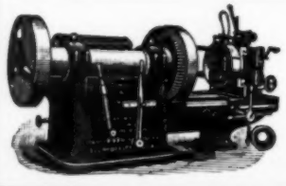

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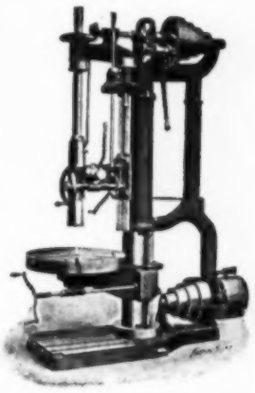

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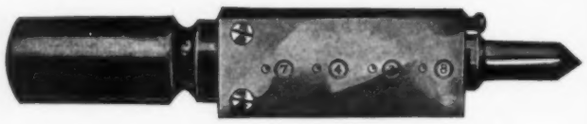
"Initiative" Revolution Counters



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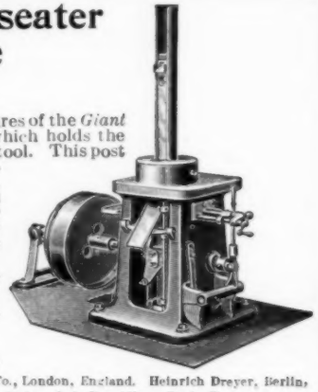
The Giant Keyseater Has Distinctive Features



One of the most distinctive features of the *Giant Keyseater*, is the grooved post which holds the work and forms the guide for the tool. This post solves the whole question of being able to obtain perfectly true, straight key-ways. It matters not whether the hole is straight or taper, if the hub is faced true, or left rough as it comes from the factory.

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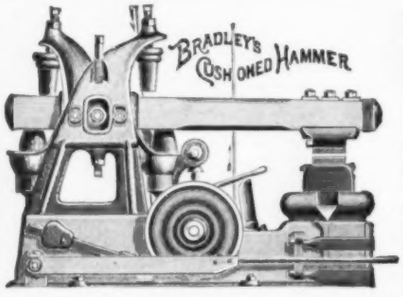


Bradley Hammers

are made in Helve (see cut), Upright and Compact styles. Many sizes of each.

For the rapid and economical duplication of forgings, for welding, plating, swaging, collaring, spindle making, etc., no other hammers approach them. A greater number sold each year than of all other power hammers combined.

Send for circulars.

C. C. BRADLEY & SON, Syracuse, N. Y.

THERE ARE NO POWER PRESSES BETTER THAN THE

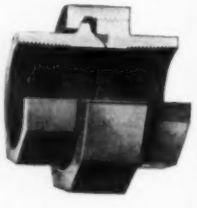
"CONSOLIDATED"

CONSOLIDATED PRESS AND TOOL COMPANY,

HASTINGS, MICHIGAN.

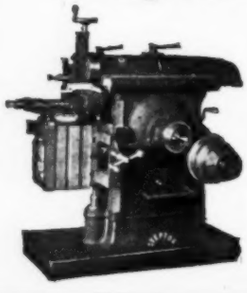
Jefferson Union Points

6 Jefferson Unions are made of Malleable Iron and the pipe ends will not stretch. Can be used over and over again, an impossibility with the ordinary type having brass ends.



Jefferson Union Co., Lexington, Mass.

The Possibilities Of Shaper Work Have Been Increased By Steptoe Shapers



And *because* they have, this tool deserves your better attention. They're powerful, dependable shapers, built for rapid, accurate work and economical results. We want to "show you" and quote prices.

The John Steptoe Shaper Co.,
Brighton, Cincinnati, O.

WE MAKE COUNTERS

which may be reset instantly from the outside, counters which cannot be reset at all from the outside; also counters unlocked with a key and reset from the inside. Adapted for paying employees by piece work, for royalty purposes, etc.

CATALOG 17?

The C. J. Root Co., Bristol, Conn.

THE CINCINNATI LATHE & TOOL CO.

CINCINNATI, O., U.S.A.

THE 16" CINCINNATI LATHES

are built with three or five step cone, also two kinds of POSITIVE GEARED FEED DEVICES for use always to the limit in any shop.

CONSIDER—This Tapping Chuck can be put into a drill, one hole tapped, Tapping Chuck put away, by a boy, in less time than a man could tap hole by hand, AND THEN IT IS TRUE.

ST. LOUIS MACHINE TOOL CO.,

ST. LOUIS, MO.

Special and Automatic Machinery

designed and built. We have had many years' experience in developing this class of machinery.

Send us samples or blue prints of the work you want to do and we will tell you what we can do in the way of building machinery to cut down your cost of manufacture.

Rowbottom Machine Company, Waterbury, Conn.

The Automatic Threading Lathe

will do from 25% to 100% more threading than an ordinary lathe. For details, see large ads., first and third issues, each month.

Automatic Machine Co., Bridgeport, Conn., U. S. A.

Alfred H. Schutte, Schuchardt & Schutte, C. W. Burton, Griffiths & Co., Marshall & Huschart Machinery Co., of Chicago, Ill., Motch & Merryweather Machinery Co., of Cleveland, Ohio. Van Dyck, Churchill & Co., Philadelphia, Pa.

Foster Machines

Are built to give excellent satisfaction under all conditions.

Tell us the kind of work you do and we will tell you how well we can serve you. By all means write us.

Foster Machine Company,

Elkhart, Ind.

Larger Output on the Hurlbut Cutting-Off and Centering Machine, because tools are always kept at maximum speed. Printed matter?

Hurlbut-Rogers Machine Co., SO. SUDBURY, MASS.

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FOR AMBITIOUS MACHINISTS.

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Mention American Machinist 6-24-'09.

LATHES, SHAPERS and RACK CUTTING MACHINES

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TRADE B&C MARK

We manufacture devices for removing

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WE MAKE THE

Marvel Portable Grinder

FOR LATHES AND PLANERS

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LATHES

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Von Wyck Machine Tool Co., Cincinnati, O.

Scientific Principles

are followed out in the design and construction of this lathe.

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TAPS STOCKS AND DIES SCREW CUTTING TOOLS

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Built to increase production; every modern feature embodied. Send name and address for new catalog.

The Mark Flather Planer Co., Nashua, N. H., U.S.A.

Albert Herbert, Ltd., Agents for France, Belgium and Italy.

Improved Independent Chucks

We make this style of Chuck in *twenty-two sizes*, varying in size by two inches from *four to forty-two* inches. Illustrated price list?

The E. Horton & Son Co.,
WINDSOR LOCKS, CONN., U. S. A.
Awards at the World's Fair.

Or Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Glasgow. Schuchardt & Schutte, Berlin, Cologne, Vienna, Stockholm, St. Petersburg and New York Fenwick, Freres & Co., Paris, France. Van Reitschoten & Houwens, Rotterdam, Holland.

A LONG SOLID GRIP THAT WON'T SLIP.

That's the guarantee you get with every Reid Drill Chuck. Why not purchase a chuck that is *known* by its work. You'll save money, time and—*drills*. Particulars?

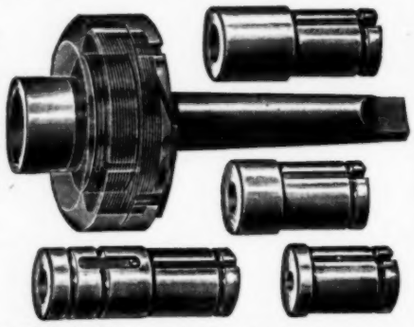
R. H. BROWN & CO., New Haven, Ct.

The Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction and is

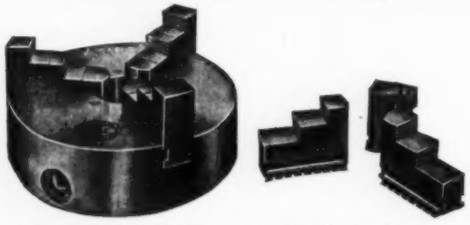
Unequaled for Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to *break* or get out of *order*. Made in 4 sizes, covering from 0 to 2½ in. diameter.



THE BEAMAN & SMITH CO., PROVIDENCE, R. I., U. S. A.

UNION GEARED SCROLL CHUCK
with 2 sets of jaws. No. 153.



Has solid shell, to stand all strains, flush, socket pinions

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UNION MANUFACTURING COMPANY,
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Almond

Inclosed Pinion Drill Chuck

With pinion and gear teeth always in perfect mesh there is practically no opportunity for wear.

T. R. Almond Mfg. Co.,
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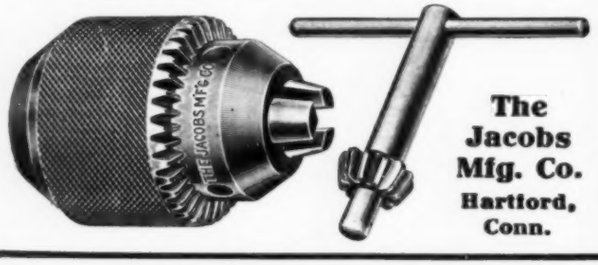
New York City, 40 Murray St. London Office, 8 White St., Moorefields.

The Simplest Chuck

is the Jacobs Improved Drill Chuck. The Toothed Sleeve and Key tell the story. No more trouble, such as goes with the old spanner method. To operate the Jacobs, is as easy as winding your watch. Write for the opinions of users.



The Jacobs Mfg. Co.
Hartford, Conn.

The Sweetland Geared Scroll Chuck

This member of the Sweetland family has all the good features of the ordinary chuck, and in addition some features peculiar to the Sweetland only. It is fitted with "Reverse" or Inside Jaws, furnished with either three or four jaws.

Write for Catalog 8 C—it's worth while.

The Hoggson & Pettis Mfg. Company.
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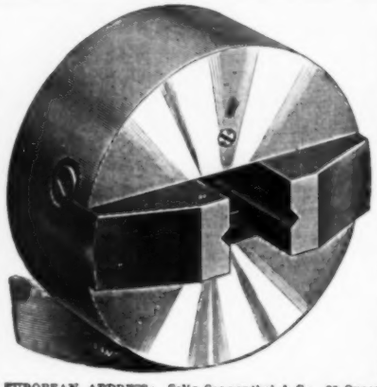

The Two-Jawed Chuck that's provided with *hardened steel thrust shoulder* for retaining the screws in place and for receiving the wear is made by

WHITON

It can be easily taken apart for cleaning, when necessary, and everything won't fall to pieces. Its many other good features are described in Chuck Book.

THE D. E. WHITON MACHINE CO.,
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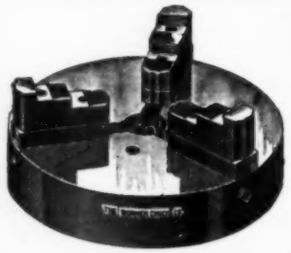
EUROPEAN ADDRESS: Selig Sonnenthal & Co., 85 Queen Victoria Street, London, E. C. "Whiton" Chucks sold and kept in stock by principal dealers all over Europe.



SKINNER
COMBINATION CHUCKS

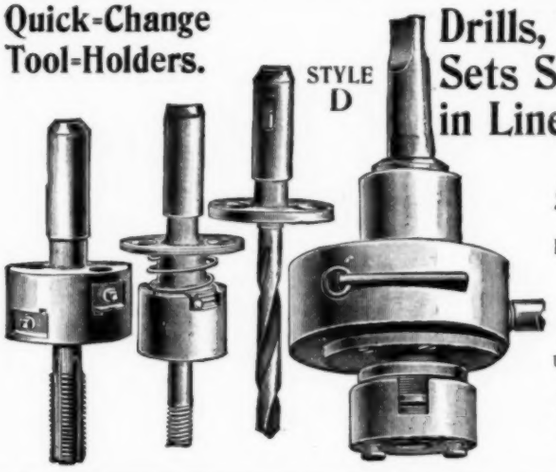
In selecting a Lathe Chuck for a great variety of work, consider our Combination Chuck.

It is carefully tested and must pass within certain limits as to accuracy before leaving factory.

The Jaws are of steel, hardened and ground true in the Chuck Body. PARTICULARS?

THE SKINNER CHUCK CO.,
NEW BRITAIN, CONN., U. S. A.
94 Roade St., NEW YORK CITY. 78-80 City Road, E. C., LONDON, E. C.

Quick-Change Tool-Holders.



Drills, Taps, Sets Studs in Line.

ERRINGTON AUTO-REVERSE

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NO { Stopping / Reversing / Moving Work / Changing Speed } TAPPING CHUCK

Fifteen years on the market have taught me

Simple Methods of Handling Work

and how to *ADAPT* my

POSITIVE, FRICTION and INTERCHANGEABLE TAPPING DEVICES

to meet

Every Condition of Tapping.

MADE IN ALL SIZES FROM 1-16 IN. TO 2 IN TAPS.

Use Style D for work that is clamped down, or work that is too heavy to center itself to the tap.

Switzerland—American Import Machinery Office, Zurich and Chaux-de-Fonds.
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England—Chas. Churchill & Co., London, Birmingham, Glasgow, Manchester, Newcastle-on-Tyne.

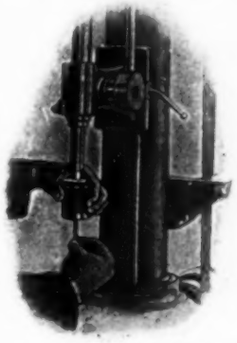
Strength, Weight And Capacity

are three features which help "Cushman" chucks hold first place.

Insist on securing chucks with "Cushman" stamped upon them, and you will use the best chucks that human skill can produce. Test our Lathe Chucks, Drill Chucks or Face Plate Jaws. We'll stand by your decision.

Catalog?

The Cushman Chuck Company, Hartford, Conn.



CAN YOU BEAT THIS

method of chucking? Look how simple it is—no key or wrench to fuss with. The left hand turns the chuck while the right hand manipulates the drill.

The Grönkvist Automatic High Speed Drill Chuck operates while machine is in motion. Saves 10 to 20 per cent. in drills.

Write for Catalog.

GRÖNKVIST DRILL CHUCK CO.,
18 Morris Street, Jersey City, N. J.

The Pratt Chuck Is a Better Chuck And Costs No More Than Those That are Not So Good.

It's better because it will drive drills positively without marring their shanks or damage of any kind. Booklet free.

Pratt Chuck Co.,
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Sole European Representatives—Selig, Sonnenthal & Co., 88 Q. Victoria Street, London, England.

1876 TRUMP DRILL CHUCK 1909

HIGH QUALITY LOW PRICE

Three sizes: 1/8", 1/4" and 3/8". Descriptive lists on application.

Trump Bros. Machine Co., Mfrs., Wilmington, Del.
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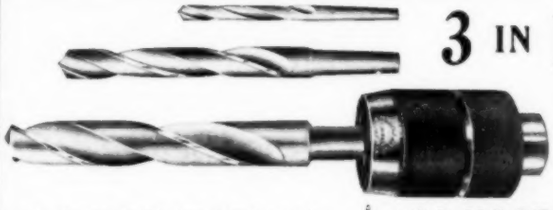
INDUCTION CLUTCH PLANER DRIVE

For A Clutch Without Contact Surfaces,
See Large Ad. June 3rd, Page 123.
Write for Bulletin No. 102.
Wheeling Mold & Foundry Co., Wheeling, W. Va.



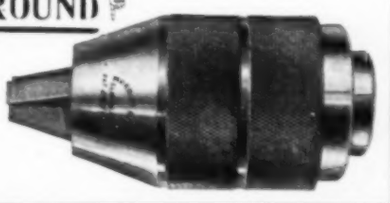
3 IN 1 MORROW CHUCKS

To Hold Tangless Drills No. 1, No. 2, No. 3 Taper Shanks
Ball Bearings—Hand Operated—Marvelous In Action

IT HAS NO EQUAL

ALL HOODS HARDENED AND GROUND

A chuck built for hard work and long service for use on drill press, screw machine or automatic, it has no equal. Jaws of special crucible steel ground on V and back. They advance and retract on a hardened and ground surface of hood. This feature overcomes springing and distortion of hoods so common in ordinary chucks. Strictly a high grade tool of superior workmanship with no exposed threads to collect grit. No bothersome keys or spanners to go astray. Its gripping and releasing qualities are a revelation to the operator.

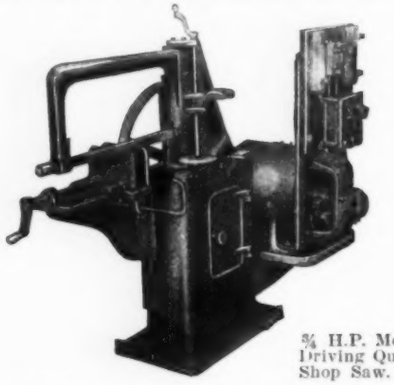


Write or ask your dealer for further information.

MORROW MFG. CO. :: Elmira, N. Y.

General Electric Company

The Advantages of Individual Motor Drive Depend Entirely on the Motor Which Does the Work.



¾ H.P. Motor Driving Quincy Shop Saw.

General Electric Motors are reliable, economical and easily operated. With General Electric Motors satisfactory operation is assured.

Manufactured in all sizes. Adapted to all uses.

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PRINCIPAL OFFICE: SCHENECTADY, N. Y.

New York Office: 30 Church St.
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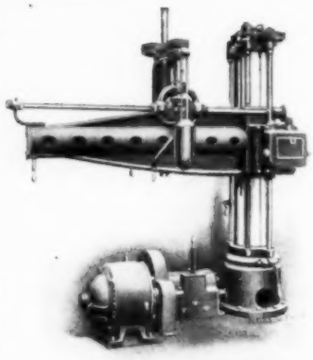
Belt Shifting Is Dangerous

to work and to workman.

HAWTHORN DIRECT CURRENT MOTORS

will give any desired change of speed, the only operation necessary being the turning of a hand wheel.

Send for Bulletin No. 1805.



Radial Drill driven by Hawthorn Direct Current Motor.

WESTERN ELECTRIC COMPANY

Eastern	Central	Western	Pacific
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Northern Electric and Manufacturing Co., Ltd., Montreal and Winnipeg.

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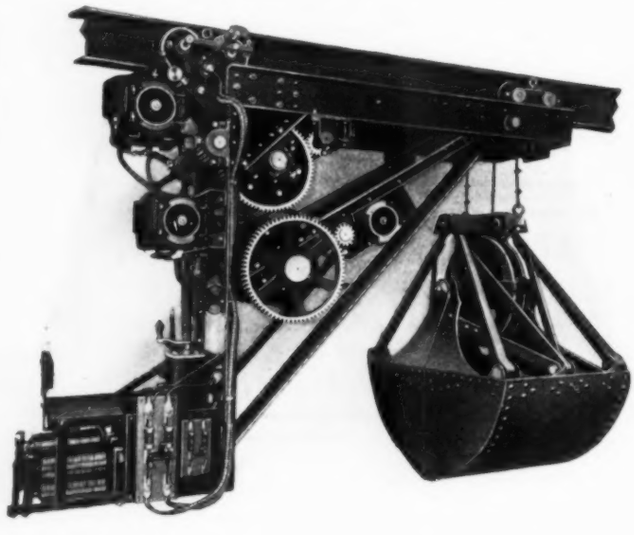

DO IT RIGHT

and save money. The old methods require more labor expense in addition to loss of time.

SPRAGUE ELECTRIC SHOVELS

are installed in the most modern plants for handling coal, ashes, ore, lime, sand, etc., and are in demand because they do it more quickly and more economically. They shovel, lift, carry, deposit and pile.

Write for a free copy of descriptive pamphlet No. 23213.

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Variable Speed Motors

TRIUMPH Variable Speed Motors for machine tool application need no introduction. The steady demand for this type of Motor is a guarantee of the high grade quality of our product.

Make Use Of Our Experience

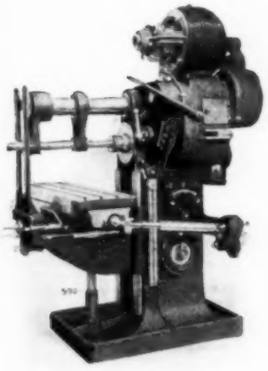
We have solved YOUR problem before—Let us figure with you on the motor question.

The Triumph Electric Co.

Cincinnati, Ohio.

FORT WAYNE

Some Of Our Best Friends



are the men in the shops doing piecework on machines driven by Northern Type Motors. They know best the reliability, the ease of securing speed variations and the overload capacities of Northern Type motors.

Northern Type Motor driving Becker-Brainard No. 5 Milling Machine.

Particular Motors for Particular Service; Particular Service from Every Motor.

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Main Office: Fort Wayne, Ind. Factories: Fort Wayne, Ind., and Madison, Wis.

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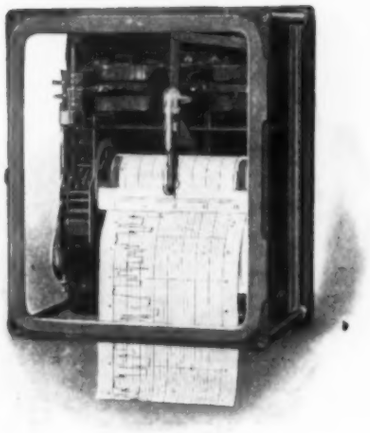
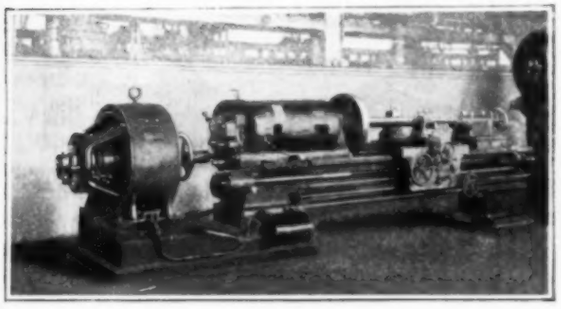


Machine-tool operation records obtained with Westinghouse curve-drawing meters

give an exact log of all that the tools do. You can ascertain the power and time used, the delays and possibilities for improved operation on any job in your shop. They will enable you to keep your cost at the minimum.

Read all about them in the "Motor Talks No. 1—Machine Tool Edition;" they're interesting



Westinghouse Motor-Driven Lathe

Westinghouse Electric & Mfg. Co.

Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Kansas City, Los Angeles, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Salt Lake City, San Francisco, Seattle, St. Louis, Syracuse

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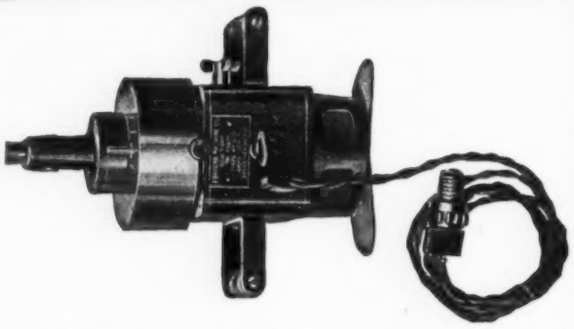

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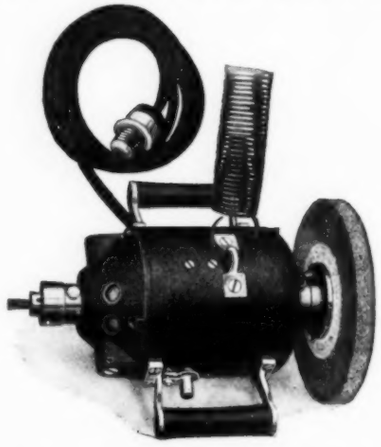
Portable Electrical Breast Or Hand Drills

are the handiest, best and most economical tools of their kind in existence. They are made in two sizes and weigh 20 and 36 lbs. Drill up to 9/16" and 7/8". Direct and alternating current. Features include *three changes of speed, ball bearings* and *extreme simplicity*, which insures their staying in perfect order. Our "*Feather-Weight*" is a little 10-pounder, for holes up to 1/4". D. C. only. Catalog sent free.

Fortuna Machine Co.,
127 Duane Street, New York.

The Improved "Hisey"
Portable Electric Tools

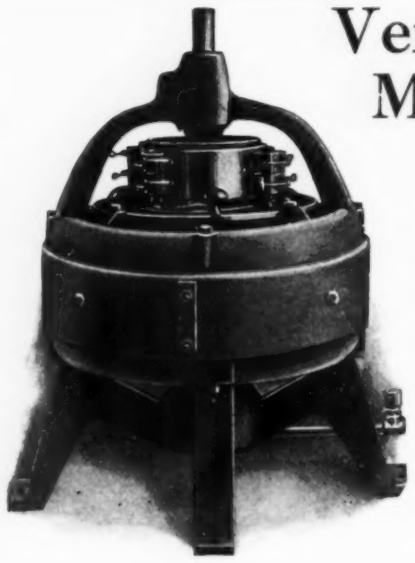
Have motors entirely enclosed, absolutely dust-proof, air-cooled. Brush-holders, lead-wires, all connections enclosed, preventing short-circuiting. Brushes removable without disturbing any other parts. All bearings adjustable to wear. Drills provided with our new patented enclosed automatic switch. All gears enclosed, running in grease, not oil. Every tool guaranteed up to its rated capacity. All tools wound for direct and alternating current. Direct current for any voltage up to 600, alternating current for any voltage up to 440, single, two or three phase.



The Hisey-Wolf Machine Co.
Cincinnati, Ohio.

New York Office: 50 Church St. Boston Office: 10 Oliver St.

Vertical Motors



particularly suitable for driving vertical or pit pumps, ventilating fans in shafts or flues, large drill presses, etc.

These and all the other motors formerly manufactured by the

C & C Electric Co.,

are now made exclusively by the Garwood Electric Company—in same factory, with same workmen—same facilities.

Garwood Electric Company,
Main Offices and Works:
Garwood, N. J.

New York, 149 Broadway. Philadelphia, West End Trust Bldg.

Keep Cool

Cincinnati Portable Electrically Driven Drills and Grinders "keep cool" because they are *air-cooled*. They are best by every test, and *service test* is the best; which accounts for our 10 days' trial offer on each machine. Drills made in 10 sizes from 3-16" to 2¼" for D C or A C. Grinders with motors up to 2 H.P. for D C or A C.

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Special machines made to order.

The Cincinnati Electrical Tool Co.
Cincinnati, Ohio.

EVEN if you have not heard much from ROTH—no reason why he cannot furnish you the BEST MOTOR on the market—he has been too busy furnishing ROTH Motors to those who quickly appreciate a good thing when they see it, to blow about GOOD ROTH MOTORS.

ROTH BROS. & CO.
463 W. Adams St., Chicago, Ill.
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Blue Chip Cold Rolled Steel

Hardened by new process, will not shrink in thickness, and in thinner gauges requires no grinding after hardening. Accuracy and smoothness guaranteed.

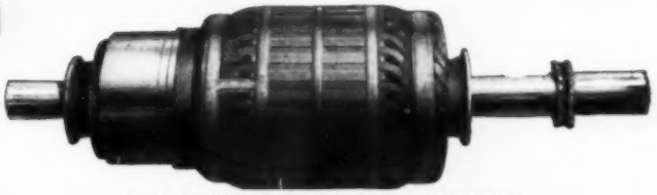
Strips for Slotting Saws made in widths ¼" to 8", thickness .006" to ¼". One Blue Chip Saw will outwear 10 ordinary steel saws.

FIRTH-STERLING STEEL COMPANY

Office and Works, McKeesport, Pa.

PITTSBURGH NEW YORK BOSTON PHILADELPHIA CHICAGO SAN FRANCISCO

WELDING BY ELECTRICITY



Armature Shaft—Weight 1500 lbs., 4" Diameter.
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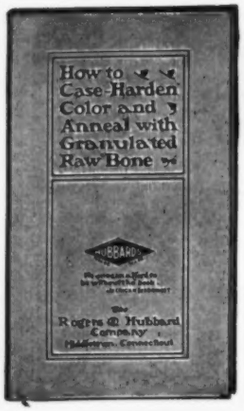

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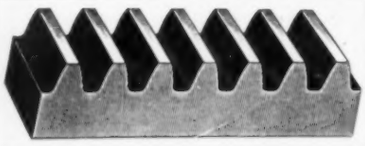

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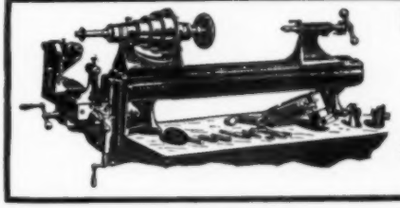

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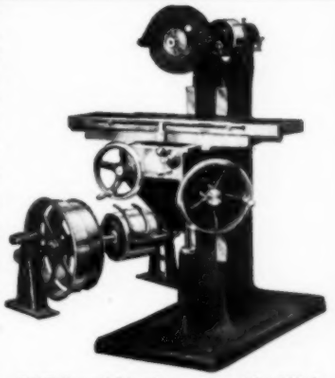

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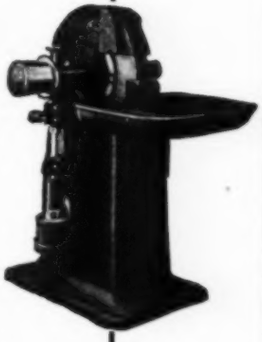

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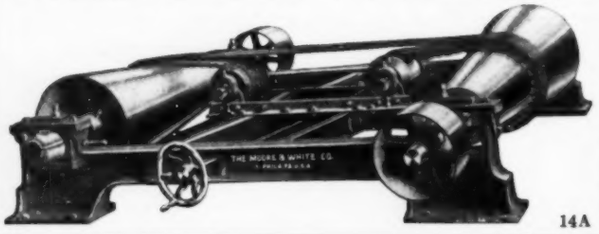

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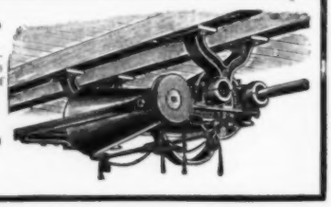

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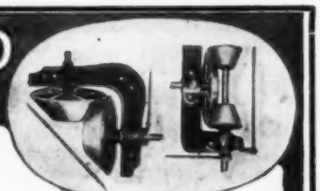

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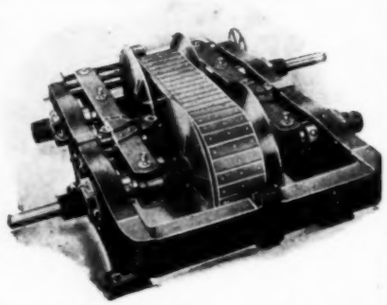

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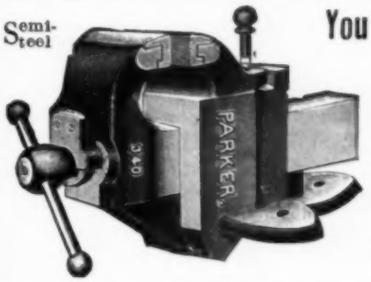

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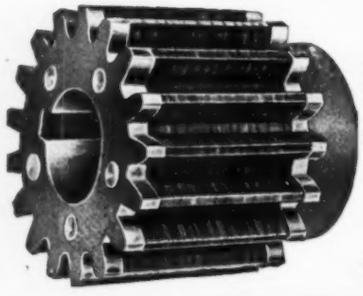

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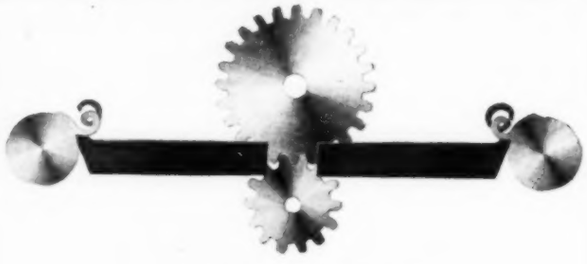

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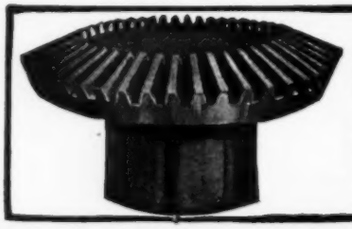

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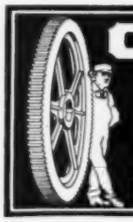

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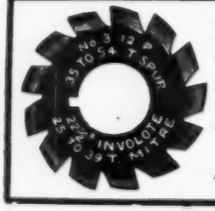

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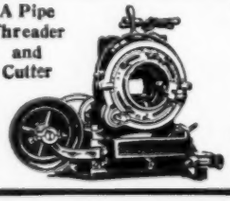

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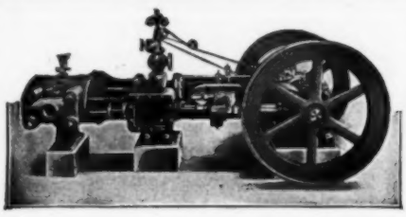

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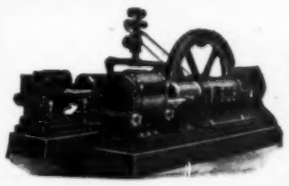

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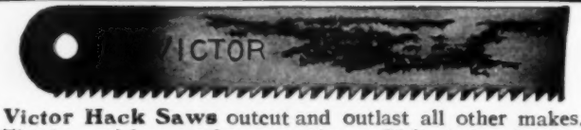

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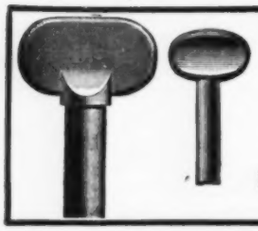

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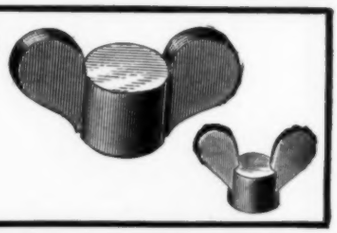

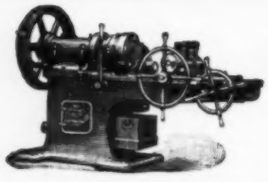

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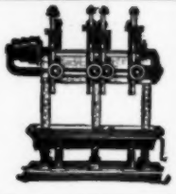

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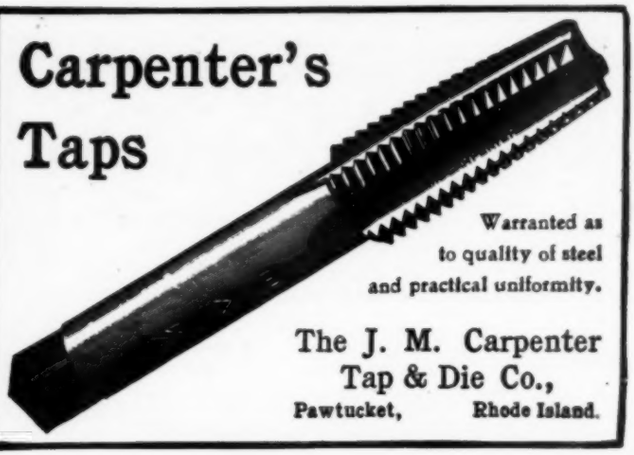

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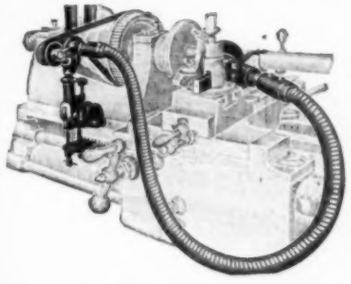

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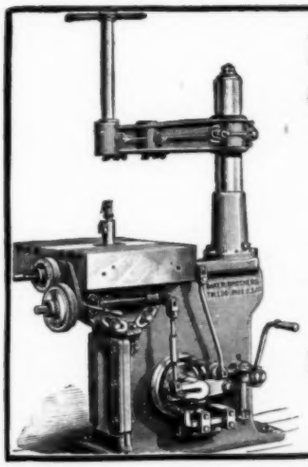

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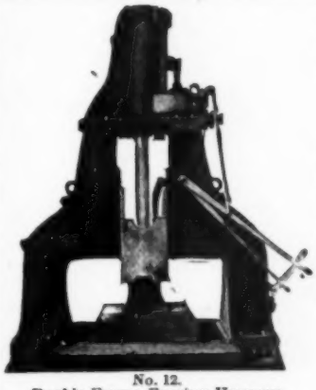

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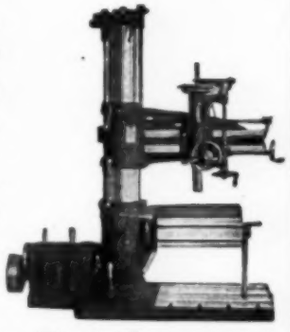

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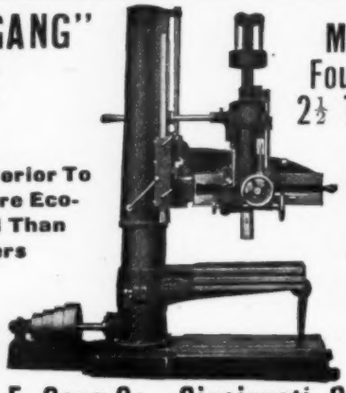

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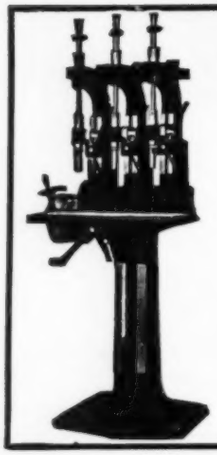

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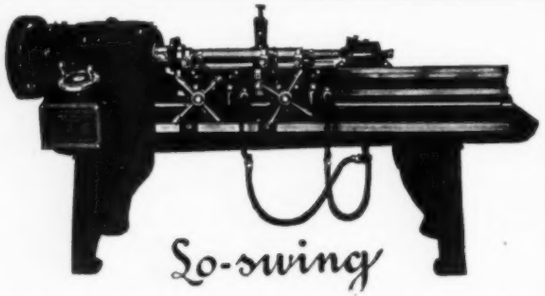

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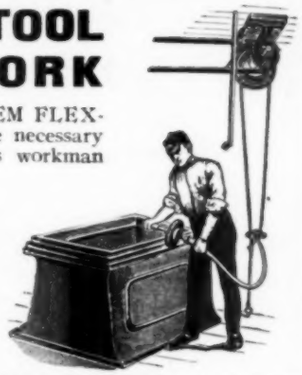

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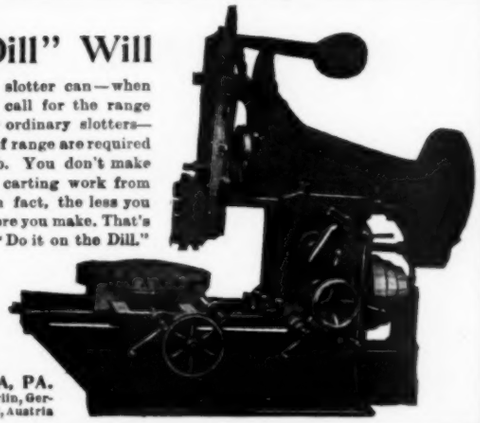

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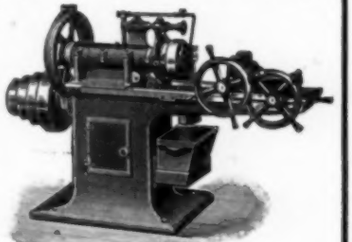
Bolt And Nut Machinery

Acme Bolt Cutters, Nut Tappers, Bolt Pointers, Bolt and Rivet Heading Machines, Forging Machines, Rotary Thread Rolling Machines, etc., possess a proved efficiency that makes them worth the immediate attention of the manufacturer who desires faster production and reduced cost. Catalog?



THE ACME MACHINERY CO., Cleveland, Ohio, U. S. A.
FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England. Schuchardt & Schutte, Berlin, Vienna, Stockholm and St. Petersburg. A. H. Schutte, Cologne, Brussels, Liege, Paris, Bilbao, Barcelona and Milan.

THE NEW

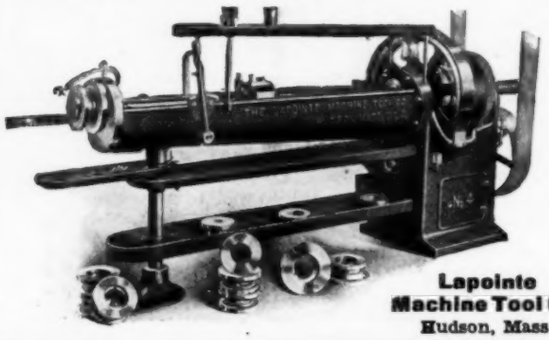
LYON TOOL BOX

Light Weight
Strong
For Hard Work

Bulletin 202-A tells about them.

LYON METALLIC MFG. CO., • Aurora, Ill.

Lapointe Broaching Machine has no equal for cutting keyways in holes or broaching holes in various shapes, square, hexagon, oval, etc. Just send us blue prints or sketches of your work and we will tell you the size of the machine and tools required.



Lapointe Machine Tool Co.
Hudson, Mass.

ITS FIRST COST is a Little Less than for some Reamers; a Little More than for others. But the

ONE-LOCK ADJUSTABLE REAMER

is in a class by itself for economy of maintenance, and for ease, quickness and accuracy of adjustment.

Get Catalog 12

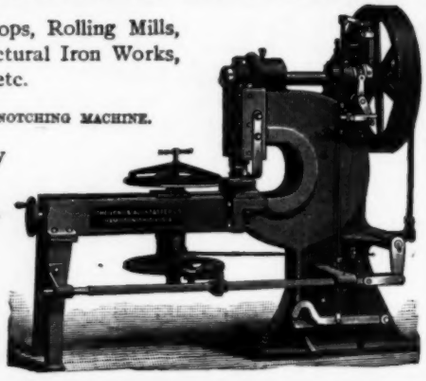
WM. J. SMITH CO., New Haven, Conn., U. S. A.

Pacific Coast Agents: Fred. Ward & Son, Inc., First and Howard Sts., San Francisco, Cal. Great Britain, France, Belgium, Germany and Austria: Sole Agents, Vickers, Sons & Maxim, Ltd., 32 Victoria St., London, S. W., England.

POWER PUNCHES AND SHEARS

For Boiler Shops, Rolling Mills, Bridge and Structural Iron Works, Machine Shops, etc.

ARMATURE-DISC NOTCHING MACHINE.



Manufactured by

The Long & Allstatter Company,

Hamilton, Ohio, U. S. A.

Shapers

Having 8 cutting speeds, T-Slots cut from solid metal, cut gears throughout table support part of machine.

GET FULL DETAILS

THE R. A. KELLY CO.,

MAKERS OF MACHINERY

P. O. Box 488. Xenia, Ohio., U. S. A.

The "Slocomb" Combination Center Drill

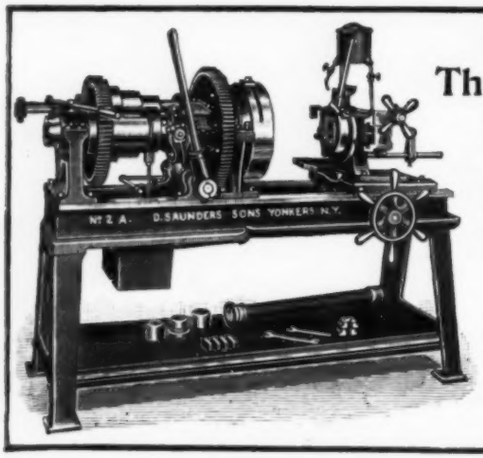
makes accurate centers, having correct angles and good clearance, without altering the drill or changing the speed of the machine.

Catalog No. 12, free on request.

J. T. SLOCOMB COMPANY,

PROVIDENCE, RHODE ISLAND, U. S. A.

Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow.
Ludw. Loewe & Co., Berlin, Agents for Continental Europe.
Thos. McPherson & Sons, Melbourne, Australia.



Pipe Threading

Cutting and Nipple Machine with patent Lever Gripping Chuck.

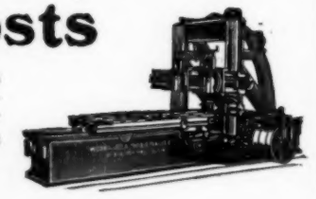
The most efficient machine known for convenience and rapid work.

Circular?

D. SAUNDERS' SONS, YONKERS, N. Y.

Low Costs

Woodward & Powell Planers have the rapid, accurate production features that lower cost of output and insure maximum economy.



Catalog 7

Woodward & Powell Planer Co.,

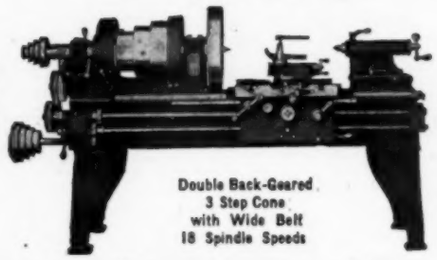
WORCESTER, MASS.

Manning, Maxwell & Moore, New York City; Philadelphia; Chicago, Ill.; Seattle, Wash.; Portland, Oregon; Milwaukee, Wis.; St. Louis, Mo.; Pittsburg, Pa.; Cleveland, Ohio; Boston, Mass.; Birmingham, Ala.; Mexico City, Mexico; Tokio, Japan; Canton and Hongkong, China. Henshaw, Bulkley & Co., San Francisco and Los Angeles, Cal. Pacific Engineering Co., Seattle, Wash. Fenwick Freres & Co., Paris, France; Belgium; Italy; Switzerland and Spain. Herman Haelbig, Dresden-A3, Germany and Austria.

Standard Engine Lathes

16 to 24 inch swing

Simple Accurate



Powerful Convenient

Double Back-Geared
3 Step Cone
with Wide Belt
18 Spindle Speeds

Greaves, Klusman & Company,
Cincinnati, O., U. S. A.

Lightning Taps "Machine Relieved"

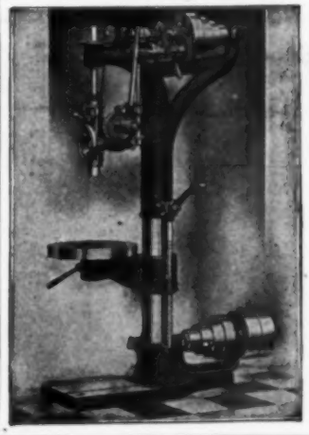
Accurate, Uniform and Serviceable

Send for catalog 34-B.

WILEY & RUSSELL MFG. CO.
GREENFIELD, MASS., U. S. A.

You May Break the Shaft,
But
You Can't Break the Grip
Of a
SHAW COUPLING

Patterson, Gottfried & Hunter, Ltd.
Distributors
147-149-151 Lafayette St. NEW YORK 211-213-215 Centre St.



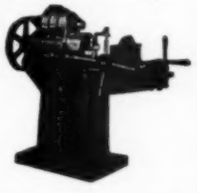
We Make Nothing But Drills

Sizes twenty to thirty-two inches, equipped with motors, gear or belt driven.

Sibley Machine Tool Co.
South Tutt Street,
South Bend, Ind., U. S. A.

The Big Feature

of the Landis Bolt Cutter is the famous Landis Die, which never needs hobbing or retempering and actually has ten times as long a life as any other. It has many other exclusive and important features that make big savings.



Ask for descriptive Bulletin.

Landis Machine Co., Waynesboro, Pa., U. S. A.

Schuchardt & Schutte, 34 Victoria St., Westminster, London, Sole Agents for Great Britain, Ireland, British Colonies. Schuchardt & Schutte, 9 Kiangse Road, Shanghai, Sole Agents for China and Japan. Adler & Eisenschitz, Milan, Sole Agents for Italy.

The Taylor-Newbold Saw

A High-Duty Inserted Tooth Saw

that meets every exacting requirement for heavy service in steel foundries, rail mills, etc., and among structural steel users in general. Will cut high carbon steel.

The saw consists of a circular steel disc with adjustable high-speed steel cutters, specially treated by the Taylor-White process and set in protecting holders. If a cutter breaks it's just the work of an instant to insert a new one without removing the saw. Get our catalog and learn full particulars.

The Tabor Manufacturing Company

Manufacturers of Moulding Machines

Eighteenth and Hamilton Streets, Philadelphia, Pa.

KNOW THE SPEED AT WHICH YOUR TOOLS ARE RUNNING

by using The Cut Meter, that shows all speeds in feet per minute instantly and without any figuring, rigging, or bother of any kind. The Cut Meter operates in any position and is not dependent on gravity, springs, or other dubious movements.

WARNER INSTRUMENT COMPANY
51-59 Roosevelt Avenue
Beloit, Wis., U. S. A.

Riveting with Light Uniform Multi-blows

at the rate of 1000 per *second* (if need be) is the principle upon which the Townsend Multi-blow High Speed Riveting Machine turns out clean, accurate work, in the shortest time and at the lowest cost. 'Tis the only machine that has the holding sleeve to level up the work. Uses *simple* tools —no expensive spinning rolls.

Write today for circular.

H. P. Townsend Mfg. Co.,
Hartford, Conn.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Paris, Brussels Liege, Barcelona, Bilbao, Milan, Turin.

BESLY GRINDERS

Let us show you what we can do for you

Illustration shows grinding of "U" Shaped Magnets, made from ⅝ in. x ¾ in. Special Magnet Steel.
Material Special Magnet Steel.
Ground on 1905 Model No. 6 Besly Spiral Disc Grinder.
Magnets are 5 in. from center of "U" to bottom of leg.
Used No. 5360, grain No. 16 Helmet Spiral Circle.
Stock removed—Just enough to clean up, from 1/32 in. to 3/32 in.
Time—375 pieces per hour.
One pair of Circles would last five hours.
The PATENTED FEATURES of No. 6 Besly Spiral Disc Grinder illustrated above are the
Spiral Grooved Steel Discs,
Helmet Spiral Circles,
Geared Lever Feed Mechanism and
Sliding Motion of Spindle.
Furthermore, with this machine, if desired, we are prepared to furnish our Patented Hinged Nut Grinding Fixture or our Patented Open Top Nut Holder.
The EXCLUSIVE FEATURES of this Machine are the Bed Construction. Heads are mounted on V's planed on Bed Castings.
Method of taking up end thrust of Spindle.
Bearing Construction and Micrometer Adjustment.
When so ordered, this machine is equipped with Automatically Telescoping Dust Hood.
End Play in Spindle Bearings is adjusted in such a way that machine can be run safely with practically all end play taken up; naturally grinding work to size WITHIN CLOSER LIMITS.
Among our 70 varieties of Besly Disc Grinders is one just suited for your work.
We would like to prove our claims on some of your samples. No charge for the demonstration.
Send us some samples and we'll grind them for you and report time and material used.

CHARLES H. BESLY & COMPANY,
(Originators of Disc Grinders)
15-17-19-21 South Clinton Street, Chicago, Ill., U. S. A.

ARMSTRONG TOOL HOLDERS

PATENTED relieved seat, reinforced support under cutter, extra large cutter and tool steel screw are a few of their many points of superiority.

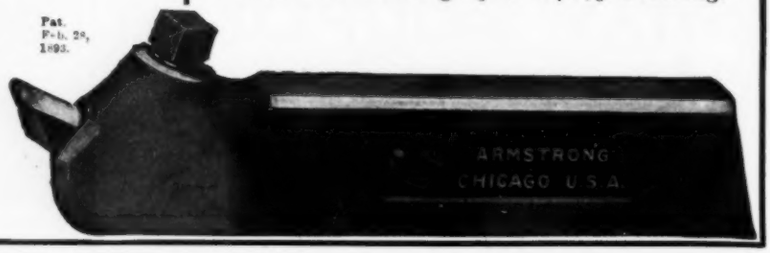
Do you want a Catalog ?

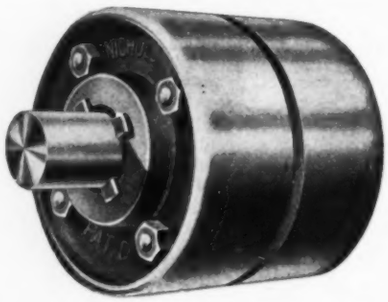
ARMSTRONG BROS. TOOL CO.,
"THE TOOL HOLDER PEOPLE"
115 N. Francisco Ave., Chicago, U. S. A.

MAKE ONE POUND OF HIGH SPEED TOOL STEEL EQUAL 10 LBS. IN FORGED LATHE AND PLANER TOOLS.

Also save all Forging and 70% Grinding.

Pat. Feb. 28, 1893.





What This Coupling Has Joined No Strain Can Put Asunder

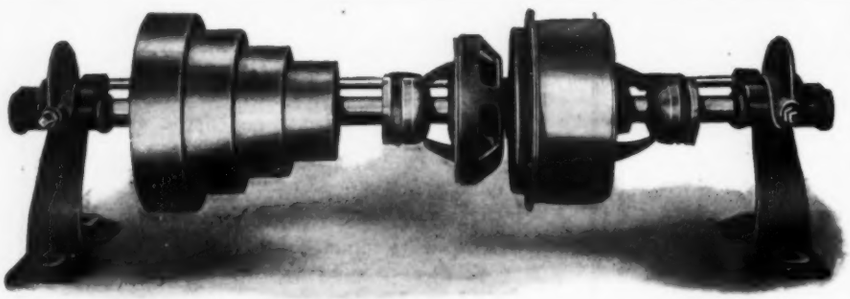
THE NICHOLSON

Compression Shaft Coupling has undoubtedly the strongest grip known. It absolutely *cannot* slip, and any strain severe enough would twist off the shaft before the coupling would give way. All sizes are carried in stock.

Ask for the circular.

W. H. NICHOLSON & COMPANY,
WILKES-BARRE, PA.

SOLE AGENTS:
THE FAIRBANKS CO., Eastern U. S., Main Office, New York.
FAIRBANKS, MORSE & CO., Western U. S., Main Office, Chicago.
CANADIAN FAIRBANKS CO., Canada, Main Office, Montreal.
A. WARDEN & COMPANY, England, Main Office, London.



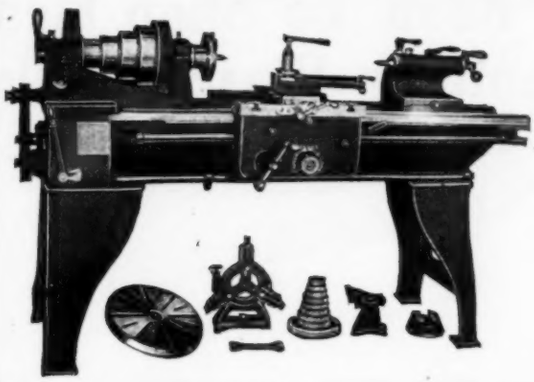
Two-speed One-Belt Countershaft, One Forward and One Reverse.

A BIG BELT SAVING

invariably goes with the installation of the Smith One-Belt Reversing Countershaft. There's an actual saving of 50% in both belt and pulleys and the price of that extra belt saved, added to the allowance your dealer will make for *his* countershaft will pay for the "Smith."

WRITE FOR MORE!

THE SMITH COUNTERSHAFT CO., BOSTON, MASS.



"Seneca Falls" Screw-Cutting Engine Lathes

WEIGHT—RIGIDITY—POWER

Are triple advantages of this line of machines. They are designed to meet the severe exactions of modern manufacturing, will handle all classes of lathe work within their range with speed and economy, have every facility for convenient operation, produce accurate results and are adapted for the general run of every-day work. Made in 12, 14 and 16 inch sizes.

Catalog "B" on Request.

The Seneca Falls Mfg. Co.

687 Water Street — Seneca Falls, N. Y., U.S.A.

142A

Screw Machine Products

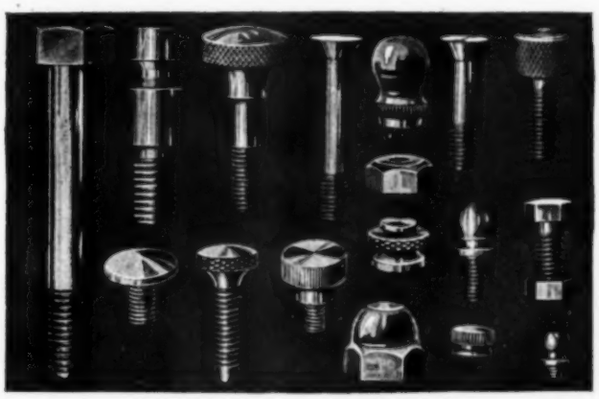
We make them of Brass, Iron or Steel—correct as to accuracy and finish.

If you wish to save money, send us some samples and let us quote attractive prices. Write today, while you think of it.

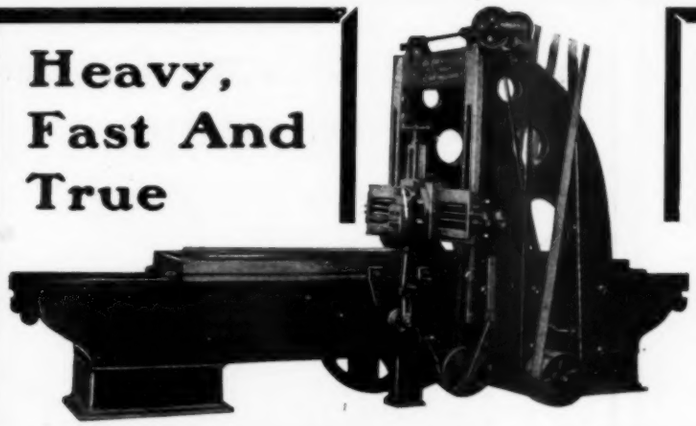
Universal Machine Screw Company

HARTFORD, CONN

Also Manufacturers of the Universal Five Spindle Automatic Screw Machines.



Heavy, Fast And True



New Haven Planers

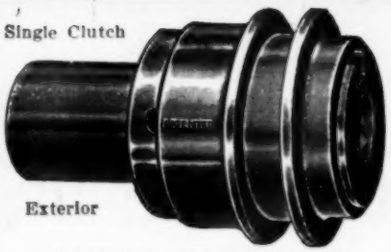
have wide, strongly braced beds, thick tables with deep ribs, heads with automatic feed in all directions, all feeds obtainable instantly without stopping machine, etc. All the features are valuable wherever fast, accurate planer work must be done.

New Haven Mfg. Co.

New Haven, Conn.

THE JOHNSON FRICTION CLUTCH

Single Clutch

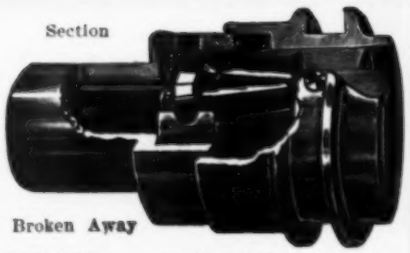


Exterior

The fewest parts for the most perfect service. Working parts completely covered, free from dust.

Send for a Blue Catalog.

Section

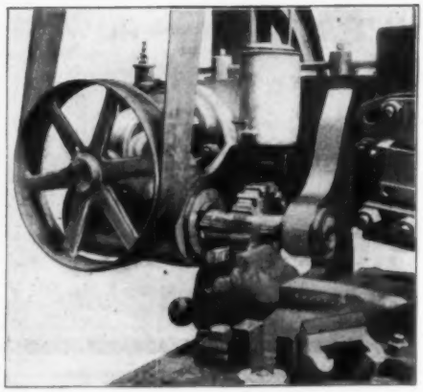


Broken Away

FOREIGN AGENTS—Efandem Co., 246 A, Corporation St., Birmingham, Eng., for Great Britain. Canadian Fairbanks Co., Montreal, Toronto, Winnipeg and Vancouver, for Canada. H. Glaenzer & Perreaud, No. 1 Avenue de la Republique, Paris, for France. Bieberstein & Goedicke, Ferdinandstr. No. 25—7 Amerikahaus, Hamburg, for Germany. Wilh. Sonneson & Co., Malmo, Sweden, for Norway, Sweden, Finland and Denmark.

THE CARLYLE JOHNSON MACHINE CO. HARTFORD CONN

A Farwell Milling Head



on a planer checks both jaws of this vise at once. It does not interfere with the use of the machine on planing jobs.

No Planer is complete without one.

Catalog 56 A.

The Adams Co.,

364 Fourth St., Dubuque, Iowa, U.S.A.

De Fries & Co., Dusseldorf, Germany. J. Lambercier & Co., Geneva, Switzerland. G. Koeppen & Co., Moscow, Russia. V. Lowener, Copenhagen, Denmark. Gleanær, Perreaud & Thomine, Paris, France. Aktiebolaget V. Lowener, Stockholm, Sweden.

A Boon To Shop Men
Sanitary Wash Bowls

More and more attention is being given by shop and factory managements, engineers and architects as well as by Health Boards, to the matter of service room accomodations for employees, esp-cially in the matter of washing up facilities and locker accomodations.

Why not investigate their merits? They cost no more than plain sinks installed.

Send for Catalog of our complete line of all metal shop and factory equipment.

Manufacturing Equipment and Engineering Co.,

209 Washington Street, Boston, Mass.

1=4

Against a

GISHOLT

and its multiple cutters,

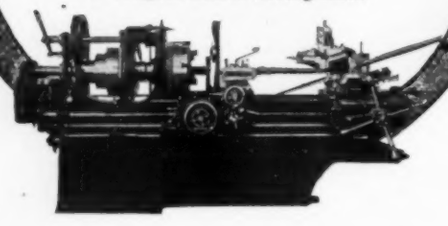
the engine lathe with single cutter has about as much chance as ordinary carbon steel has against the best high speed.

Gisholt Machine Company

Madison, Wisconsin.

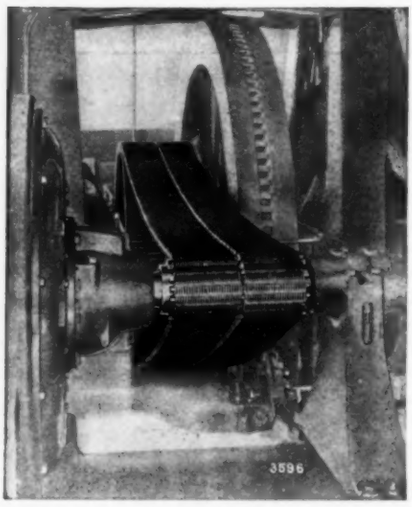
Chicago Display Room, 101 Washington Blvd.

Investigate Gisholt Boring Mills.



Renold Silent Chain

THE MAXIMUM



Link-Belt Company

Philadelphia Chicago Indianapolis

New York: 299 Broadway,
Boston: 84 State Street,
Buffalo: 601 Ellicott Sq.

Pittsburgh: 1501-02 Park Bldg.
St. Louis: Missouri Trust Bldg.
Seattle: 439-440 New York Block.

BANG!!!

Nearly as many Ball Bearing Drilling Machines sold in 1909 up to April 1st as during the entire year of 1908.

There's a Reason.

It's 200% to 400% Advantage.

Catalogue ?

THE HENRY & WRIGHT MFG. COMPANY,

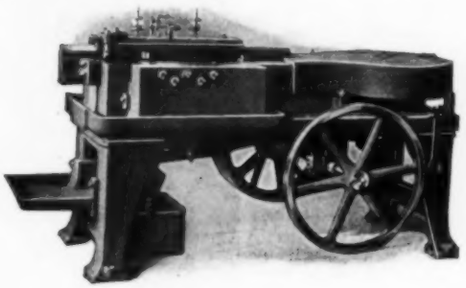
HARTFORD - CONN.

Patented.

A stock of our machines is carried by our agents, Hill, Clarke & Company, New York, Boston and Chicago. W. M. Pattison Supply Company, Cleveland, Ohio. The E. A. Kinsey Company, Cincinnati, Ohio. J. W. Wright & Company, St. Louis, Mo. W. E. Shipley Machinery Company, Philadelphia, Pa. Smith-Booth-Usher Company, Los Angeles, Cal. Bailey-Smith Machinery Company, San Francisco, Cal. C. H. Wood Company, Syracuse, N. Y.

FOREIGN COUNTRIES—Wilh. Sonesson & Co., Malmo, Sweden and Copenhagen, Denmark. G. Koeppen & Company, Moscow, Russia.

Do You Use Rolled Thread Screws?



If so, you certainly should lose no time but *immediately* send for our Catalog D-16 as it contains valuable information and you may also convince yourself that we make

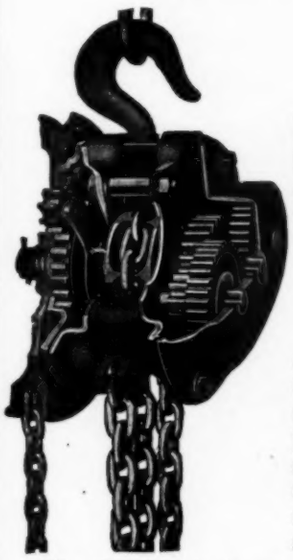
Exactly What You Want.

BUILT ONLY BY

The E. J. Manville Machine Co.

Waterbury, Conn., U. S. A.

It's Light and It's Safe



THE PEERLESS HOIST

Beside that, it's rapid and noiseless in operation; all gears are spur gears of steel with cut teeth; all parts are interchangeable; all working parts are enclosed in dust proof cases and the load can be held at any point automatically.

The Peerless is the smooth, easy running hoist for your lifting—the kind you don't need to worry about.

Your dealer will tell you about it—or write us.

Edwin Harrington, Son & Co.

INCORPORATED

Philadelphia, Pa., U. S. A.

CUT IT OFF

IN TWO SECONDS

What? Why a piece of Steel, Nickel or Brass Tubing, ½" in diameter, on the Abrasive Metal Cutting Machine.

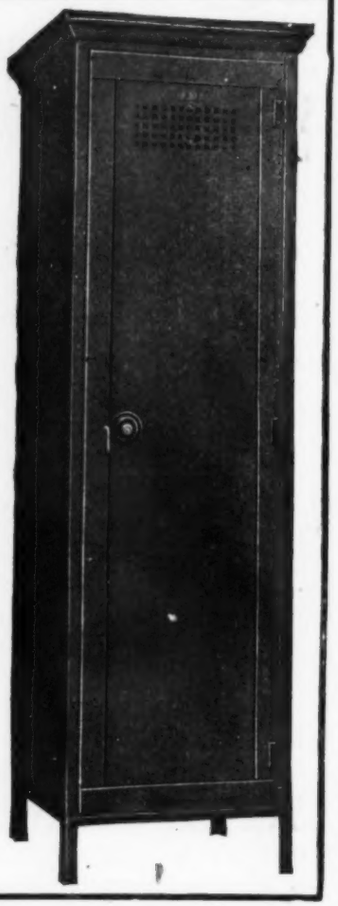
This machine has revolutionized metal cutting. Cuts everything: *Air Hardened Steel* included, in record time. High Speed or Carbon Steel 5/16" Square Bars in 5 seconds, ½" bars in 10 seconds, *without drawing the temper.* Records talk! The work is done by a Specially Prepared Abrasive Wheel, 3/32" in thickness and 12" in diameter.

Write for details and prices.

SLACK MFG. COMPANY

Springfield, Vt., U.S.A.

A LOCKER THAT HOLDS A LOT



This HART & COOLEY LOCKER is made especially for holding *more* than the ordinary amount of paraphernalia.

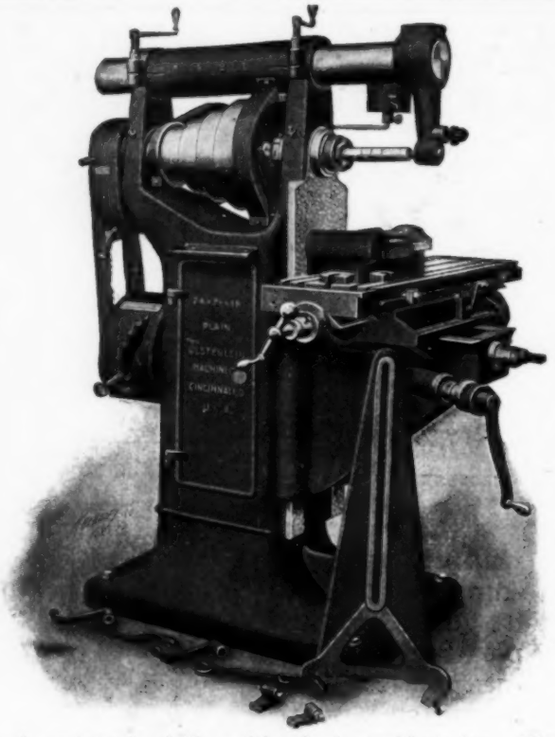
The inside fittings can be arranged as follows: Trouser hangers, coat hooks, shelves and shoe rack. Fittings can be furnished however to meet local conditions.

"H&C." Lockers are made in all styles and furnished with our own special tamper-proof locking devices--Three-Way Lock, or Slide Lock.

Write for our NEW Catalog "B"

THE HART & COOLEY CO.,

NEW BRITAIN, CONN.



An extremely rigid, positive feed manufacturing milling machine is our No. 24 Plain, shown here. We specialize in milling machines.

The Oesterlein Machine Co., **Cincinnati, Ohio**

AGENTS—Hill, Clarke & Co., Boston, Chicago New York, Philadelphia and Cleveland. J. J. McCabe, New York. National Supply Co., Toledo, O. Compressed Air Machinery Co., San Francisco. Pacific Coast Mfg. Co., Los Angeles. Kellogg & Co., Toronto. E. Sonnenthal, Jr., Berlin, Cologne, Vienna and Frankfort, A. M.

Morse Chain Drive to Lea-Simplex Cold Saw.

The smooth, noiseless performance of The Morse Rocker-Joint Chain

is a feature that forces itself upon the notice of the observer. High efficiency, nearly 99%, is another feature soon appreciated. It operates at high speeds and on short centers.

Morse Chain Company

Ithaca, New York

Licensees for Great Britain and Europe: The Westinghouse Brake Co., Ltd., 82 York Road, Kings Cross, London, N.

Right Drive, Right Feed, Right Results

The Higley Saw drive consists of a steel sprocket which engages radial slots in blade near periphery. Thus the blade is pulled through the metal.

Higley Saws

have an automatic friction feed adjustable for all sizes of work. This feed and the "pull" drive allow the Higley to work right up to the limit of the strength of the saw teeth.

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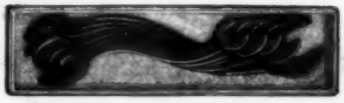

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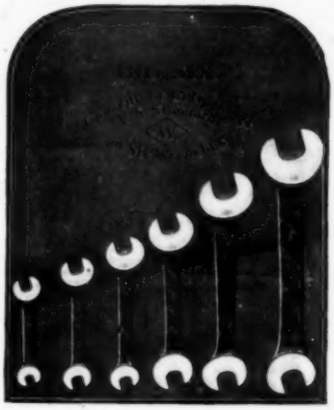

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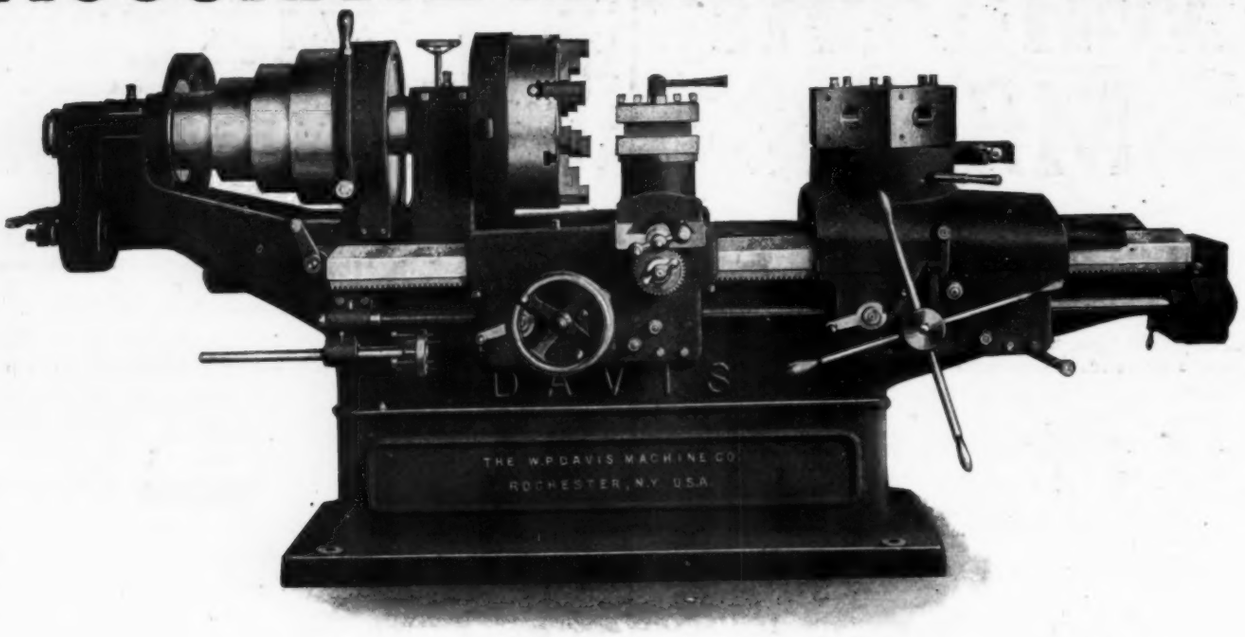

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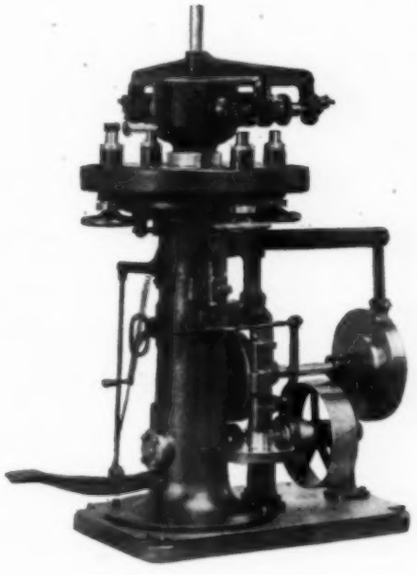

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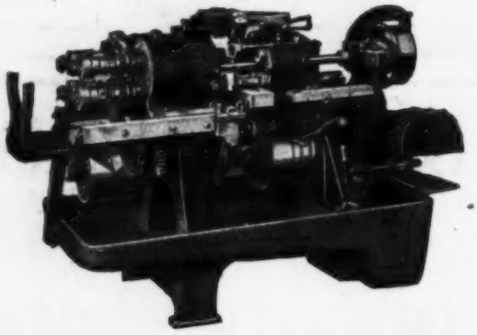

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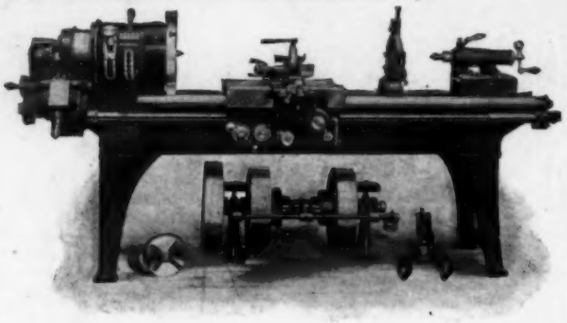

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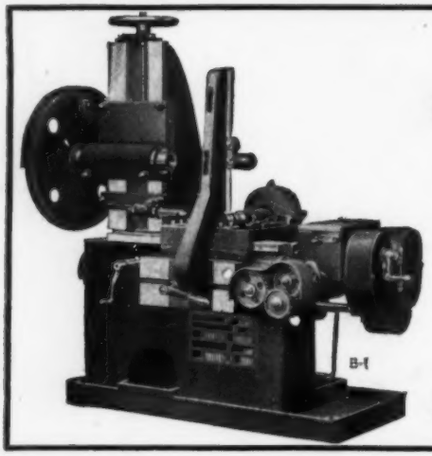

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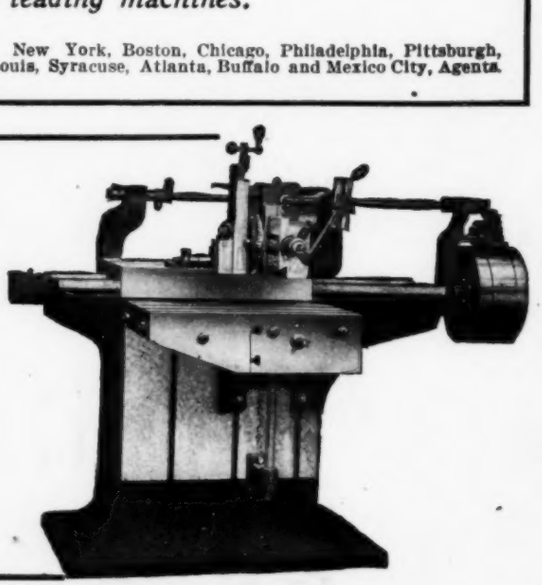

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